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(6) DATA SUMMARIZATION IN A WEATHER MODIFICATION EXPERIMENT: I. A RESPONSE SURFACE APPROACH,

by

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This paper reports on one of a series of investigations on summarization of precipitation data in weather modification experiments. A response surface approach is used with raingage location coordinates as independent variables. The method is applied to data made available by North American Weather Consultants from Phase I of their Santa Barbara Convective Test Seeding Program. After

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!. ABSTRACT (Continued)

ıvestigations, two-dimensional general cubic functions were used to describe ːecipitation response. These surfaces were integrated to produce total preipitation measurements over designated target areas of interest and the varinces of such estimates were obtained. Advantages of the approach lie in the lexibility of the choice of target area and the permissible variation in the ımpact area of a particular convective band.

PREFACE

This report deals with the necessary first phase of analysis of weather modification experiments, namely the process of summarization of precipitation data. Usually precipitation attributable to experimental units is measured through a network of raingages. Methods of summarizing such data can vary in sophistication from the use of simple averages to aggregated responses obtained from a response surface or through use of major components of variation (say, principal components).

In this report we examine the use of response surface fitting in application to data from Phase I of the Santa Barbara Convective Band Seeding Test Program conducted for the Navy by North American Weather Consultants. We are indebted to NAWC for provision of data tapes for our analyses.

A second technical report on the use of principal components in precipitation data summarization is anticipated. Other technical reports associated with this contract are listed at the end of this report.

Ralph A. Bradley
Principal Investigator

DATA SUMMARIZATION IN A WEATHER MODIFICATION EXPERIMENT:

I. A RESPONSE SURFACE APPROACH[1]

by

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I. INTRODUCTION

The fundamental and first question in regard to demonstration of seeding effects in weather modification experiments to enhance precipitation relates to appropriate summarization of precipitation data from an experimental unit of such an experiment. Experimental units in weather modification experimentations are usually either a fixed unit of time, a given number of hours. a day, a season, or alternatively the duration of some storm system. Variation over experimental units may be so large as to forestall any meaningful study of treatment (seeding) effects.

One of the objectives of the research on the design and analysis of weather modification experiments at the Florida State University is the development of better statistical methodologies to summarize and measure precipitation data from an experimental unit. If this can be done, a contribution will be made towards better formulation of statistical models and improved precision in consideration of treatment (seeding) effects.

Notwithstanding the importance of summary measures of precipitation, the weather modification literature contains little on efforts in this direction. Most studies use simple averages of raingage measurements or at least some function of these averages, for example, ratios of target-to-control area means. Since raingage measurements represent rainfall at a set of points,each of which represents a much larger and ill-defined area,

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averages based on them or any transformations thereof may not give a good representation of true total rainfall in any desired area. There is clearly a need for investigation of improved summarization methods, particularly if the objective is to increase precipitation in the watershed of a reservoir.

Research at the Florida State University has the objective of the development of statistical methodology for improved design and analysis of weather modification experiments. But applications of new methodology are necessary and the NAWC Santa Barbara data was made available for this purpose. Initial work under this contract was divided into two main parts, summarization of precipitation data for each experimental unit and the identification, summarization, and, in some cases, recovery of concomitant information on the experimental unit that may correlate with precipitation and reduce the inherently high experimental errors associated with cloud-seeding experimentation. Our basic tenet is that improved experimental design can best be obtained through improved identification and measurement of concomitant, cloud-physics variables. This report deals with summarization of precipitation data. Other reports will deal with available concomitant variables on the NAWC Santa Barbara data. Use of covariance analysis for reexamination of the effects of cloud seeding is planned when appropriate data summarization is complete.

In this report, major attention is focused on the use of response surface methods to summarize precipitation data. Other approaches included the use of multivariate methods and examination of ratios of average target-to-control area precipitations. Some review of the Santa Barbara experiment is given.

This report is broadly organized in the sequence in which the work proceeded. Since the method of summarization proposed is tested with data made available by NAWC from Phase I of their Santa Barbara Convective Band Seeding Test Program, Section II deals with a brief description of these experiments and the data

generated from them. The analyses of the generated data as done by NAWC and their conclusions are also contained in this section. Section III presents a discussion of data used in response surface study and their comparisons and contrasts with data used in two reports prepared by NAWC. A pilot study to determine the appropriate functional form of response surfaces was first initiated through use of observations from twelve experimental units. A discussion on the alternative forms of response surfaces fitted, analyses of distributional patterns of residuals from these surfaces, and the distributional patterns of the observed precipitation data are contained in Section IV. Section IV also includes discussion of a basic computational problem due to badly centered independent variables in regression models that arose in the initial phase of the surface fitting work. The pilot study showed that the appropriate forms of response surfaces were two-dimensional cubic functions with location coordinates as independent variables. The cubic surfaces were fitted to raingage measurements for control and target areas separately and for each experimental unit. A discussion of these surfaces as representative of precipitation response data is contained in Section V. Finally, Section V contains the derivation of summary indices of precipitation, representative of rainfall volumes in designated areas and their relationships with simple averages of raingage measurements.

II. THE SANTA BARBARA EXPERIMENT AND DATA ANALYSIS

2.1 The Background. Salient features of the Santa Barbara Convective Band Seeding Test experiments and their data analyses as reported by Elliott and Thompson [4] and Thompson, Brown, and Elliott [7] are summarized. The summary is intended to give an overview of the experiment and analyses to provide a meaningful background to the data set used in our suggested precipitation data summarization.

The Santa Barbara experiments were conducted in two phases between the years 1967 and 1974 by North American Weather Consultants under the sponsorship of the Naval Weapons Center (NWC), China Lake, California. Phase I of the experiments was conducted from the 1967-68 season to the 1970-71 season; Phase II was from 1971-72 to 1973-74. These experiments had the objective of demonstrating the effectiveness of cloud seeding and seeding methods in west coast cyclonic winter and spring storms. During Phase I, the primary seeding mode was ground based (from a mountain crest at 1065 meters above mean sea level) with use of a high-output, silver-iodide, pyrotechnic device ignited at intervals during the passage of convective bands (defined later). During Phase II, the seeding mode was aerial with a continuously burning acetone - Ag I - NH_4I jet seeder. Some experimental air-seeding was done concurrently with Phase I operations: the results were included in Phase II analyses. Some ground based seeding was done during Phase II also, mainly as a back-up for aerial seeding. The focus in this section is on precipitation data from Phase I since these data are used in application of the response surface methodology. Later analyses of Phase II data are planned.

All of the raingage stations which were upwind or west of the ground seeding station were designated as control-area stations and the ones downwind or east of the seeding site were designated as target-area stations.

The experimental unit for the Phase I Santa Barbara experiments was chosen to be a convective band - a series of cloud cells arranged in a line. This choice was made on the basis of investigations by Aerometric Research Inc. (an affiliate of NAWC) under contract to the National Science Foundation. Procedure for identification and tracking of convective bands was developed. This procedure consisted of alerting the seeding technician of a probable band passage if either (i) one of six stations[1] in the control area registered at least 0.02" rain in a fifteen minute period or (ii) the radar operated by NAWC reported a banded echo. Confirmation of band passage was given in case of an alert through procedure (i) above if either another of the six control-area stations registered a 0.02" rain in a subsequent fifteen minute period ... or the radar operator reported an incoming convective band. In case of 'alert' through procedure (ii), the band was confirmed if any of the six control-area stations registered 0.02" rain in a fifteen minute period provided this coincided with the radar position of the band. Further, the seedability of a confirmed band was determined on the basis of wind flow compatible with the expectation that effects of seeding would fall mainly in the target area. An additional seeding criterion based on air-mass structure was specified but could not be used in actual operation.

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[1]These stations are N3, S201, S204, S235, S251, and E 7946.

Table 1 below gives the distribution of bands by seasons and by months within each season for the four seasons of Phase I operations. It is seen from this table that in all 107 bands were considered seedable. Actually, several more bands considered seedable during January and February of the 1968-69 season were not seeded since these months turned out to be months of unusually heavy rainfall and seeding operations were terminated

Table 1: DISTRIBUTION OF BANDS BY SEASONS AND MONTHS: PHASE I

Month / Season	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	TOTAL
1967-68	-	-	6(2)	8(3)	4(3)	4(3)	22(11)
1968-69	4(1)	6(3)	17(9)	11(5)	1(0)	2(1)	41(19)
1969-70	2(1)	-	9(4)	5(4)	6(4)	-	22(13)
1970-71	7(5)	10(5)	-	2(1)	1(1)	2(1)	22(13)
	13(7)	16(8)	32(15)	26(13)	12(8)	8(5)	107(56)

Figures in parenthesis are numbers of bands seeded.
Source: Constructed from [7], Appendix C.

due to threats of flooding. A random process was used to select 56 bands for seeding. The project was initiated in mid-January of 1968 and therefore there are no data in the table for the months of November and December of the first season. The largest number of seedable bands occurred in January and February of 1968-69; these were months of above-average monthly rainfall. March and April for all the four seasons and November and December for 1969-70 had below-average monthly precipitations. Further, there was a drought in Southern California from January in 1971 and thus there were only 5 seedable bands in as many as four months of the 1970-71 season.

2.2 Basic Information Collected and Broad Outlines of Analyses Made. During the passage of a band, a number of measurements were recorded. The Santa Barbara data are among the best available since attention was given to statistical design and a substantial amount of concomitant information was collected. Important information gathered during the course of band passage is as follows:

(i) Raingage percipitation measurements from a network of stations in control and target areas.

(ii) Estimated duration of band passage time in minutes at each raingage station.

(iii) Number of fusees ignited by band.

(iv) Airmass structure of the band in terms of one of three stability categories.

(v) 500 mb. temperature.

The network of stations for which the estimates of total precipitations and durations by band were obtained is similar to that of the map presented in Appendix Figure A-1. Airmass structures and 500 mb. temperatures were obtained from radiosonde soundings with GMD-1 equipment at Santa Barbara airport along with similar soundings taken at nearby government installations during the course of band passage. Since 'start' and 'end' times of band passage were noted [4] and [7], the information on whether the band passed through in night or day could also be derived.

Precipitation and duration analyses were done using what were termed composite single ratios (S.R.) and composite double ratios (D.R.). The word 'composite' is used to indicate that these ratios use data from all the four seasons in contrast to individual season data. Calculation procedures for S.R. and D.R. are explained below in terms of precipitation data.

Let y_{ij} denote precipitation at station i from band j. Let $\delta_j(i) = 1$ or 0 as band j is seeded or not seeded and station i is operative, $\sum_j \delta_j(i) = N_s(i)$, the number of seeded bands, while $N(i) - N_s(i) = N_{ns}(i) = \sum_j [1-\delta_j(i)]$, the number of non-seeded bands recorded at station i, $N(i)$ being the total number of seedable bands recorded. Precipitation averages were defined as

$$\bar{T}_{s(i)} = \sum_j \delta_j(i) y_{ij} / N_s(i)$$

and

$$\bar{T}_{ns(i)} = \sum_j [1-\delta_j(i)] y_{ij} / N_{ns(i)}.$$

These are station averages for station i respectively for seeded and non-seeded bands. Let ℓ index the six control-area stations used in band detection. Then

$$\bar{C}_{s(\ell)} = \sum_j \delta_j(\ell) y_{\ell j} / N_s(\ell)$$

and

$$\bar{C}_{ns(\ell)} = \sum_j [1-\delta_j(\ell)] y_{\ell j} / N_s(\ell),$$

and $\bar{C}_{\bar{s}}$ and $\bar{C}_{\overline{ns}}$ are the corresponding averages over the available control area detection stations. For station i, the composite single ratio was defined as

$$S.R.(i) = \bar{T}_{s(i)} / \bar{T}_{ns(i)} \tag{1}$$

and the composite double ratio was

$$D.R.(i) = (\bar{T}_{s(i)} / \bar{C}_{\bar{s}}) / (\bar{T}_{ns(i)} / \bar{C}_{\overline{ns}}). \tag{2}$$

It is stated that each of these sets of composited single and double ratios was subjected to a Mann-Whitney U test to test the null hypothesis that seeded and un-seeded precipitations were drawn from the same population versus the alternative that precipitations from seeded bands were stochastically larger than those from the unseeded bands. Mann-Whitney tests were performed for each station separately. Definition of the relevant two samples is not clear from [4, 7]. It appears that the test of significance at station i for the single ratio is simply based on the precipitation measurements y_{ij} separated into two samples as band j is seeded or not. In regard to use of the composite double ratios, the precipitations y_{ij} may have been used in ratios $y_{ij}/\bar{C}_j$ where $\bar{C}_j$ is the precipitation average for the (at most) six control stations for band j, the division of these ratios into two samples being again on the basis of seeding or non-seeding. It is noted that composite double ratios cannot be obtained from individual members of the two samples as defined above.

Double ratios were designed to include correction for the natural intensity of a given band through division by a measure of control-area average precipitation. However, various analyses indicated that normalizing the single ratios (1) by the use of control-area averages to obtain double ratios did not materially change the results. Therefore, it was determined that a control was not needed for evaluation. Thus, the final report [7] contains analyses only of single ratios.

Table 2 gives the distribution of stations by the magnitude of single ratios for precipitations in Phase I of the Santa Barbara experiments. This table also contains the breakdown of this distribution between target- and control-area stations.

Table 2: DISTRIBUTION OF NUMBER OF STATIONS BY RANGES OF SINGLE RATIOS FOR PHASE I PRECIPITATION

RANGE OF SR		0.995 and less	1.000 - 1.195	1.200 - 1.395	1.400 - 1.595	1.600 - 1.795	1.800 - 1.995	2.000+	TOTAL
FREQ. OF STATIONS	TARGET	1	6	20	22	7	1	4	61
	CONTROL	6	20	10	3	-	-	-	39
	ALL	7	26	30	25	7	1	4	100

Source: Derived from [7, Appendix II]. See page 4 for definitions of Target and Control Areas; see Table 3 below for definitions used in our data summarization.

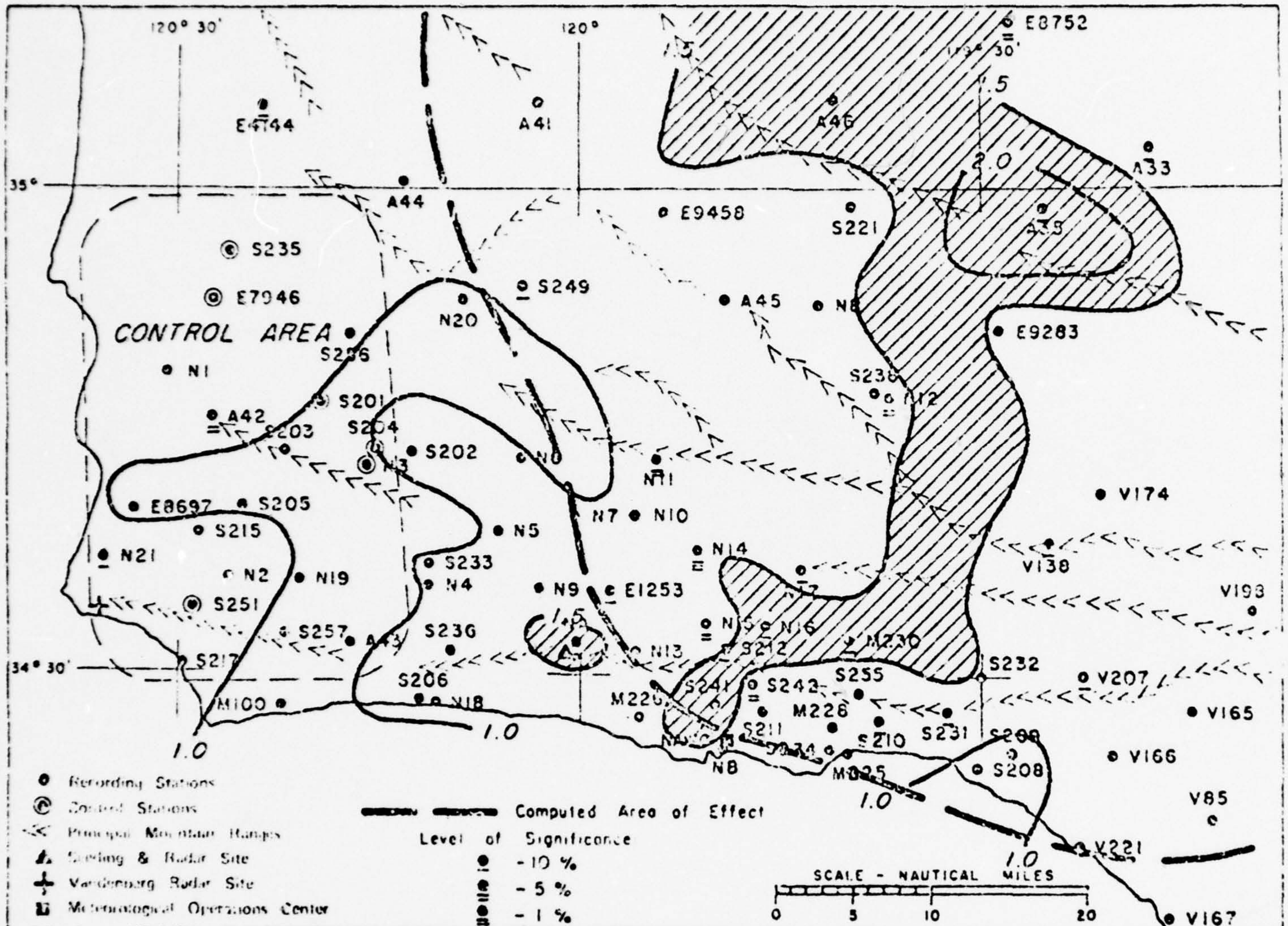
It is seen from this Table 2 that, while the mean of single ratios for target-area stations appears higher than that for control-area stations, both target-and control-area averages exceed one. This is indicative of higher precipitations from seeded bands than non-seeded bands. But it happens also in control areas, a possibility suggesting contamination effects. There are 27 out 61 target area stations which recorded values of S.R. less than 1.4. Quite a few of the 22 stations in the next S.R. class of 1.400 to 1.595 had, in fact, values less than 1.5. Therefore, about half of the target-area stations may have had precipitation increases from seeded bands in excess of 50 percent. It is noted, though, that 4 stations in the S.R. class 2.000+ seem to be outlying observations. Single ratios in them are unduly large - one as large as 7.32 (Station A27), while a neighbouring station A23 has the smallest observed S.R. value of only 0.79.

Caution in interpretation of Table 2 is required. While effects of seeding seem indicated, the single ratios yielding the distributions of the table are not stochastically independent and are, indeed, highly correlated, are based on the same experimental units (convective bands), and sometimes result from stations in close proximity. Further investigation is needed,

either in analysis of Table 2, or through confirmation of the apparent effects in Table 2 by more appropriate statistical methodology.

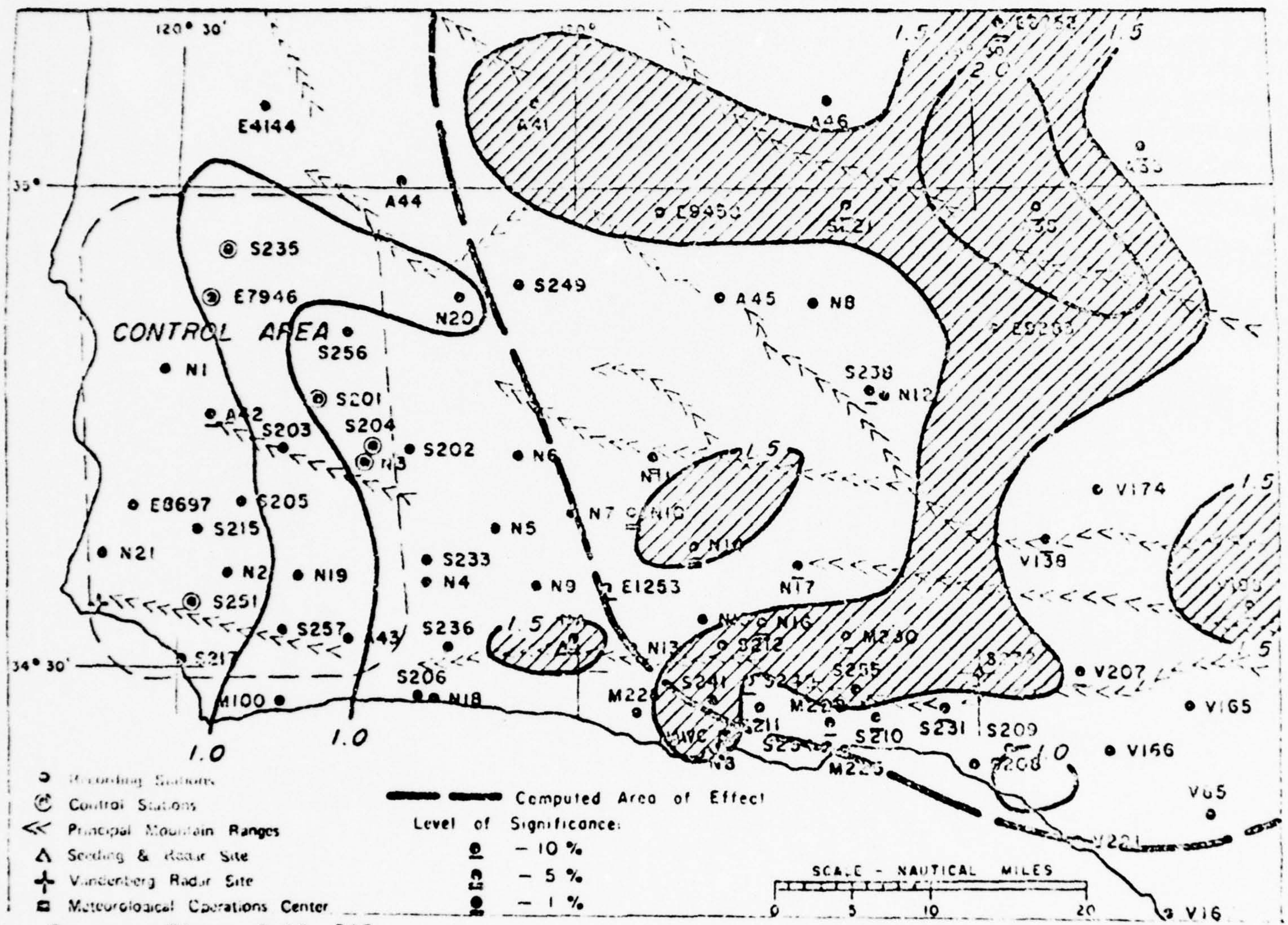
The NWC reports contain interesting 'area of effect' maps. Two of these maps - one for composite single ratios and the other for composite double ratios of precipitations are shown for illustration purposes in the following two pages. When a band is seeded, silver iodide particles drift, diffuse, and produce ice particles which in turn grow, drift, and descend to earth. The envelope of ground interception points of the collection of particles is termed the "area of effect". The heavy dotted line forms the boundary of the expected area of effect. The shaded area is that subset of the area of effect wherein the precipitation increase was 50% or more. According to the reports, extensive portions of the area of effect had ratios (both S.R. & D.R.) of 1.5 or more as indicated by these maps.

Figure 1: Composite double ratios of precipitation for 1967-71, all bands, ground seeded, 56 seeded and 51 not-seeded.



Source: Figure 5.2, [4].

Figure 2: Composite double ratios of precipitation for 1967-71, all bands, ground seeded, 56 seeded and 51 not-seeded.



Source: Figure 5.12, [4].

This section would be incomplete without a summary of conclusions arrived at in the NWC reports [4, 7]. A brief synopsis of the main conclusions is presented below.

Evidence is conclusive, say the reports, that cloud seeding is an effective means of increasing precipitation. Average precipitations due to seeding increased by 50% or more in majority of target area stations. There was an attempt to post-stratify the bands by their air-mass sturctures and 500 mb temperatures. The reports conclude that average precipitations in warm and unstable bands increased by more than 100% and covered a much larger portion of the target area. Seeding is most effective when 500 mb temperatures are between -17°C and -20°C. There is some evidence to the effect that day-time seeding is less effective than night-time seeding. Most importantly, the reports conclude that the effect of seeding is through an increase of band duration rather than an increase of band intensity, that is, the larger average precipitations in seeded bands can be attributed to longer band durations. Data summarization in this report and in ONR Technical Report No. 118 is preliminary to reanalysis of the Santa Barbara Data. The objectives of the reanalysis are both to evaluate the use of more sophisticated statistical methods and to sharpen, confirm or refute conclusions drawn initially by NAWC.

III. DATA USED FOR RESPONSE SURFACE APPLICATIONS

We review data used below in this report in application of response surface methodology. North American Weather Consultants had two projects (concurrently), one for the Naval Weapons Center at China Lake, California, and the other for the Bureau of Reclamation at Denver, Colorado. The analysis undertaken for the Bureau of Reclamation used a much larger network of raingage stations than used for the Naval Weapons Center study. This increase in the number of raingage stations resulted from an extension of the target area to the east. While the two reports discussed in Section II were done on behalf of the Naval Weapons Center, there is a third report by Brown, Thompson, and Elliott [1], which was done for the Bureau of Reclamation with the larger network of raingage stations.

The first of the two Naval Weapons Center reports, written in February 1972, had only 80 raingage stations. A list of these stations is contained in Appendix B of [4]. All single and double ratios in this report were calculated for these 80 stations. The second and the final report (October, 1975) had 112 raingage stations listed in Appendix A, [7], out of which 72 were common with the list in [4]. That is, from the list of stations in the former report, eight stations were dropped and forty added to arrive at the list in the latter report. However, single ratios in [7] are reported only for 100 stations, that is, 12 stations listed in Appendix A of [7] were again dropped from the analysis. On the other hand, the report done for the Bureau of Reclamation attempted to use a network with about 178 raingage stations, 100 of which were common with NWC report [7] and 78 were further additions. The reasons for dropping or adding stations are not clear. There are stations which have been dropped from the analysis but have precipitation data available for them: N9 and N10 are examples of such stations.

A slightly different kind of problem, potentially capable of introducing an element of noncomparability among various analyses, relates to missing observations. There are a substantial number of raingage stations, which are in the analyses, but have large amounts of missing precipitation data. In fact, there are few stations which have precipitation measurements for all 107 convective bands. Clarifications on this problem were sought from NAWC and reasons given were: (i) some raingages were changed to a different type of measuring device, (ii) some raingages were added in the course of the experiment, and (iii) there were equipment failures.

NAWC provided a magnetic tape containing data on all variables (except location coordinates of stations) collected during the course of the Santa Barbara experiments and used either for NWC analyses or for the Bureau of Reclamation analyses. This tape consists of 18 files, each with a different data set. File #12 has precipitation data for 178 stations from 107 experimental units (bands). Locations coordinates, latitudes and longitudes in degrees and minutes and altitudes in meters, were provided by NAWC for each of the 178 stations separately.

The precipitation and location data first considered in application of the response surface methodology consisted of data for the 178 stations discussed above. The locations of these stations are summarized in Table 3.

Table 3: LOCATIONS OF RAINGAGE STATIONS BY LATITUDES AND LONGITUDES

	$LO \le 118^o$	$118^o < LO < 120^o\ 01'$	$LO \ge 120^o\ 01'$	
$LA \le 34^o$	3	5	0	8
$34^o < LA < 35^o 15'$	6	107(3) *(Target)	34 (Control)	147(3)
$LA \ge 35^o 15'$	1	10	9	20
	10	125	43	178

*Three stations, A45, E6006, and E8832, were omitted from our analyses because of incorrect altitude specifications.

Stations labelled Target and Control in Table 3 were used in our final analyses with these two areas defined by the indicated bounds on latitudes and longitudes; the remaining stations and regions were omitted because it was judged that precipitation measurements were too sparse or that they were too far from anticipated regions of effect. The division between Target and Control areas remains a north-south line slightly to the west of the ground-seeding site at latitude $34^{\circ}32'$ and longitude $120^{\circ}01'$. Our major study is based on 107 Target area stations and 34 Control area stations.

Appendix Figure A-1 contains a map showing locations of many of the raingage stations originally considered to be used for testing the response surface approach to band summarization data. Appendix Tables A-1 and A-2 give a listing of Target and Control area stations actually used together with their three location coordinates. A similar listing of stations not used is contained in Table A-3.

IV. THE CHOICE OF RESPONSE SURFACES

4.1 Introduction. Our approach to the summarization of precipitation data is in two stages. In the first stage, a response surface is fitted to the raingage measurements for each convective band separately for defined control and target regions. The independent variables for both regions are simply the raingage location coordinates, latitude and longitude. In the second stage, integrals yielding volumes under the surfaces respresentative of total precipitations for specified areas of interest are calculated as a summarization of the precipitation data. Thus, various calculated precipitation volumes may be derived to measure the response to a band in the target area and similar volumes may be used for the control areas as possible concomitant variables describing the "strength" of the band. The use of this data summarization will be reported later in conjunction with concomitant data summarized by Gleeson in ONR Technical Report 118.

Preliminary analyses of various kinds were conducted and they are reported in Sections 4.2 and 4.3. These preliminary studies were based on selected bands from the data set for this purpose. Aspects of investigations of goodness of fit of response surfaces are reported also.

Not all possible analyses can be considered and inevitably other approaches would be selected by other investigators. Surface-fitting techniques are available also through various computer packages that have the effect of smoothing responses over areas of interest. Such a "local" surface fitting program was available and was tried. But little is known about the probabilistic interpretations possible and we believe that these routines tend to over-fit data. A discussion of such methodology as used in meteorology is given by Stephens [6]. The use of these procedures was rejected but they could

yield summarization methods of use. The basis for the decision was that high correlation with simple averages of precipitation were anticipated and, indeed, this occurred with our method also.

4.2 Pilot Study on Selected Bands. The appropriate choice of regression equation to be fitted with latitude and longitude of raingage stations as independent variables is important. A pilot study was conducted on selected bands to determine the simplest regression equation that would adequately approximate data from all bands.

Bands for the pilot study were selected to be representative of the totality of bands. Twelve bands were selected, six early in the experimentation and six late. Three of the early and three of the later bands were seeded. The convective bands used for the pilot study were bands 1, 2, 3, 4, 5, 7, 94, 95, 96, 97, 98, and 99. The six seeded bands were 4, 5, 7, 94, 95, and 96. In the pilot study, Station N21 in the Control Area was omitted because a corrected latitude specification was needed and later supplied. This accounts for minor discrepancies between control-area table entries for the pilot study given in Tables 5, A-4, A-5 and A-6 and complete summary data given in Tables A-8, A-10 and A-12.

Early work showed that altitudes of raingage stations were not helpful in the description of response surfaces nor were transformations of the precipitation measurements. Polynomial regression models of degrees one, two, and three respectively in latitude and longitude were fitted to raingage measurements for all the twelve bands and for target and control areas separately. For a given band and region, let y_j be precipitation at station j in inches, x_{1j} be latitude of station j in degrees, x_{2j} be longitude of station j in degrees. The three models used in representation of y_j were

$$y_j = \delta_0 + \delta_1(x_{1j} - \bar{x}_1) + \delta_2(x_{2j} - \bar{x}_2) + \varepsilon_j, \tag{3}$$

$$\begin{aligned} y_j = \gamma_{00} &+ \gamma_{10}(x_{1j} - \bar{x}_1) + \gamma_{01}(x_{2j} - \bar{x}_2) \\ &+ \gamma_{20}(x_{1j} - \bar{x}_1)^2 + \gamma_{11}(x_{1j} - \bar{x}_1)(x_{2j} - \bar{x}_2) \\ &+ \gamma_{02}(x_{2j} - \bar{x}_2)^2 + \epsilon_j, \end{aligned} \tag{4}$$

and

$$\begin{aligned} y_j = \alpha_{00} &+ \alpha_{10}(x_{1j} - \bar{x}_1) + \alpha_{01}(x_{2j} - \bar{x}_2) \\ &+ \alpha_{20}(x_{1j} - \bar{x}_1)^2 + \alpha_{11}(x_{1j} - \bar{x}_1)(x_{2j} - \bar{x}_2) + \alpha_{02}(x_{2j} - \bar{x}_2)^2 \\ &+ \alpha_{30}(x_{1j} - \bar{x}_1)^3 + \alpha_{21}(x_{1j} - \bar{x}_1)^2(x_{2j} - \bar{x}_2) \\ &+ \alpha_{12}(x_{1j} - \bar{x}_1)(x_{2j} - \bar{x}_2)^2 + \alpha_{03}(x_{2j} - \bar{x}_2)^3 + \epsilon_j, \end{aligned} \tag{5}$$

where $\bar{x}_1$ and $\bar{x}_2$ are the arithmetic means of latitudes and longitudes of stations in use for any particular convective band and, in each model, ϵ_j is a random error. For each model, the regression coefficients given by Greek letters must be estimated. The subscript j in the equations above runs over the n_i stations, somewhat different from band to band. $\bar{x}_1$ and $\bar{x}_2$ are also different for different bands for the same reason.

The pilot study on choice of model was initiated to find the simplest adequate model. The possibility of use of a model of higher degree than those in (3) - (5) was open and it had been hoped that a second-degree model might be adequate. In the end, model (5) was necessary and use of this model did seem suitable in that data summarization was our goal, the cubic model fitted substantially better than the quadratic model, and residual variation about the cubic model seemed relatively free of systematic effects.

Table 4 gives the proportion of precipitation variation R^2 explained through use of linear, quadratic, and cubic response surfaces in the target area for each of the twelve test bands. This table also reports on the mean precipitation $\bar{y}$ and the measure of unexplained variation after fitting cubic response surfaces (MSE-cubic). Similar information for regressions in the control area is given in Table 5. Computations of the various quantities reported in Tables 4 and 5 have been done using standard regression methods. Equations (3) - (5) were fitted as shown because initial failure to center the independent variables x_1 and x_2 led to computational problems. Bradley and Srivastava reported on this matter in ONR Technical Report 111.

Table 4: SUMMARY STATISTICS FOR POLYNOMIAL REGRESSIONS ON THE TARGET AREA FOR SELECTED BANDS

				R^2			
Band No.	n	$\bar{y}$	s^2	LINEAR	QUADRATIC	CUBIC	MSE (CUBIC)
1	75	.0637	.00484	.21877	.34970	.45271	.00302
2	75	.1028	.00781	.20342	.37915	.49288	.00451
3	75	.1665	.00986	.00709	.13967	.15379	.00949
4*	75	.0376	.00116	.04631	.20771	.26880	.00096
5*	84	.1527	.00823	.16722	.26992	.56887	.00397
7*	88	.0352	.00259	.32275	.39495	.50881	.00142
94*	91	.0170	.00062	.31691	.48785	.58231	.00029
95*	94	.1328	.01288	.45663	.52864	.59322	.00580
96*	93	.6634	.17825	.58399	.65960	.75583	.04825
97	93	.4362	.13965	.48312	.59804	.64237	.05536
98	93	.0940	.00769	.20961	.31405	.36529	.00542
99	92	.8258	.18003	.28664	.37727	.45371	.10916

*Bands with asterisks are seeded.

Table 5: SUMMARY STATISTICS FOR POLYNOMIAL REGRESSIONS ON THE CONTROL AREA FOR SELECTED BANDS

Band No.	n	$\bar{y}$	s^2	R^2 LINEAR	R^2 QUADRATIC	R^2 CUBIC	MSE (CUBIC)
1	15	.1013	.01090	.31404	.67735	.74744	.00771
2	15	.2540	.00776	.42010	.51983	.70191	.00647
3	16	.0900	.00331	.22049	.63129	.91370	.00071
4*	16	.0563	.00120	.01788	.46845	.88551	.00034
5*	16	.1450	.00837	.53032	.80450	.93254	.00141
7*	16	.1125	.00480	.43388	.79435	.86047	.00168
94*	28	.0693	.00342	.24475	.29054	.35515	.00331
95*	32	.1138	.01290	.37361	.59504	.60594	.00717
96*	32	.3009	.05700	.62736	.74825	.79654	.01634
97	32	.2822	.04215	.36790	.55173	.58024	.02493
98	32	.0622	.00162	.05370	.16038	.28034	.00164
99	31	.6835	.03151	.03765	.17507	.26798	.03294

*Bands with asterisks are seeded.

Values of R^2 in Tables 4 and 5 measure the fraction of variation in precipitation measurements explained by linear, quadratic and cubic models for each band for target and control areas. In general, substantial improvement resulted for use of the quadratic model over the linear and for use of the cubic over the quadratic. The decision to use the cubic model rather than to proceed to a higher degree model came also from examination of residual variation as discussed below. Indications of heterogeneous error variability in both the observed data and the residual errors comes respectively from the values of s^2 and MSE (Cubic) columns. This indicated heterogeneous variability must be considered in further analyses and suggests use of weights, for example, in planned covariance analyses.

Plotting techniques were used extensively in determination of choice of response surfaces. It is not possible to include complete sets of plots but results are illustrated for Band 96, Target area, a seeded band with relatively high precipitation. Appendix Figure A-2 gives a plot of the precipitation data. Linear, quadratic, and cubic response surfaces as fitted to the data are given in Appendix Figures A-3, A-4 and A-5. In Figure A-5, it is apparent that the cubic surface becomes negative in the lower left corner of the target region, but recall that this portion of the region is not a land area and of no consequence in further use. All these surfaces are similar over regions of major interest. Figures A-6, A-7, and A-8, exhibit residual variation, departures of observed precipitations from the fitted surfaces. In general over the test bands, linear and quadratic models tended to leave residuals with some systematic patterns, both in regard to signs and magnitudes. Residuals from cubic surfaces were relatively but not completely free of such systematic effects. Some further examination of residuals follows in the next subsection.

4.3 Preliminary Investigations of Distributions and Transformations.

This subsection contains an examination of distributional properties of (i) precipitation measurements across stations within a band and (ii) residual data from linear, quadratic and cubic response surfaces. In addition, we report briefly on the use of transformations.

Two types of studies that directly consider distributions of raingage measurements exist. One type of study fits specific distributions, usually Gamma or log normal, to precipitation data. A consequence of such study may be to select a supposedly appropriate statistical test, perhaps a nonparametric one to examine seeding effects. Examples of this can be found in Dennis and Schock [2] and in Duran and Mielke [3]. Hanson in ONR Technical Report 119 has considered asymptotic comparisons of

efficiencies of certain rank tests for this project. A second type of study considers transformations to "normalize" data. Smith, Adderly and Bethwaite [6] report on use of the square-root transformation in an experiment in South Australia.

We applied two transformations to precipitation data to determine if these data showed any evidence of becoming more nearly normally distributed following transformation than before. The first transformation is logarithmic and commonly used. The second is a double logarithmic transformation devised after the first was judged unsatisfactory. The exact forms are:

$$X = \ln (1 + Y) \tag{6}$$

and

$$Z = \ln (1 + X), \tag{7}$$

where Y is the observed precipitation. Tables A-4 to A-6 show, for the twelve test bands and control and target areas, values of the variance, standardized skewness, and standardized kurtosis for the precipitation data, the z-transformations, see (7), of the precipitation data, and the residuals from the cubic surface fitted to precipitation data. Data is on file in similar computations for the transform (6) and for residuals from linear and quadratic surfaces; results are not reported here because they are intermediate to those shown.

The asymmetric and usually high peakedness of precipitation distributions motivated the choice of transformations (6) and (7). It is known that logarithmic transformations help to "normalize" skewed and leptokurtic distributions. However, in our case, transformations chosen helped only marginally to shift downwards the higher moments of the distributions. The drops in variance and skewness are too small to be of any consequence and the reductions in kurtosis, even though substantial for some bands, are

far from enough to make them close to those for a normal distribution. The conclusion is that the transformed variables X and Z are not normal. These results are consistent with those reported in the literature. A further conclusion is that any benefit resulting from transformation before surface fitting is more than offset by the interpretative difficulty that would result if surfaces were fitted to transformed precipitations. Some other transformations were tried also but were not helpful.

Investigations into the distributional aspects of residuals for stations within a band from fitted response surfaces were also undertaken. The residual e_j at station j is defined as $y_j - \hat{y}_j$ where y_j is the observed precipitation at station j and $\hat{y}_j$ its estimated value using the appropriate response surface. It is clear from Table A-6 that the residual distributions in the target area are always right-skewed. The kurtosis for residuals from all bands and all response surfaces were also positive, and sometimes very high in magnitude. One conclusion is that residuals from cubic fits had right-skewed and extremely leptokurtic distributions in the target area.

We have made the decision to fit precipitation responses without transformation to response surfaces which are the general cubic in two dimensions, latitude and longitude. Other decisions could have been made and other investigations could have been conducted. At some point, decisions must be made. Justification of our decision is that our primary purpose in the fitting of response surfaces was for data summarization. The option of transforming response statistics calculated from the surfaces is still open and will be considered.

4.4 Correlations in Polynomial Regression. It was detected early in the surface fitting work that the independent variables (latitude and longitude) were such that the absolute sample correlation coefficients

between each of them and their powers turned out to be close to unity. This caused difficulty in obtaining least squares estimates of regression coefficients. The problem was investigated by Bradley and Srivastava and they have reported in ONR Technical Report 111. While the problem has been noted by others, its rationalization may be of value both in research and teaching. The difficulty was removed on this project through centering of the independent variables in the computational work.

V. CUBIC RESPONSE SURFACES AND ESTIMATION OF VOLUMES OF PRECIPITATION

5.1 Introduction. Since the pilot study showed that cubic response surfaces provide adequate description of raingage measurements for a given region and band, surface fitting work was completed for all experimental units (bands) and target and control regions with use of two-dimensional cubic response surfaces with latitude and longitude as independent variables. These fitted surfaces were then integrated over designated geographical areas to evaluate the volume of rainfall in that area for that band. This section first summarizes the cubic surface fitting work and then goes on to discuss evaluation procedures for rainfall volumes together with their variances.

5.2 Cubic Surfaces. The cubic response surfaces with latitude and longitude as independent variables, were fitted to all 107 experimental units (bands) and for target and control areas separately. The polynomial regression model used to fit cubic surfaces is given by the equation,

$$
\begin{aligned}
y_j = {} & \beta_{00} + \beta_{10} (x_{1j} - \alpha_1) + \beta_{01} (x_{2j} - \alpha_2) + \beta_{20} (x_{1j} - \alpha_1)^2 \\
& + \beta_{11} (x_{1j} - \alpha_1) (x_{2j} - \alpha_2) + \beta_{02} (x_{2j} - \alpha_2)^2 + \beta_{30} (x_{1j} - \alpha_1)^3 \\
& + \beta_{21} (x_{1j} - \alpha_1)^2 (x_{2j} - \alpha_2) + \beta_{12} (x_{1j} - \alpha_1) (x_{2j} - \alpha_2)^2 \\
& + \beta_{03} (x_{2j} - \alpha_2)^3 + \epsilon_j
\end{aligned}
\qquad (8)
$$

for observation (station) j, where y_j, x_{1j}, and x_{2j} are precipitation measurement, latitude, and longitude at station j, $j = 1, 2, \ldots, n$, and ϵ_j is the random error associated with the response y_j. The constants, α_1 and α_2, represent the centering locations used for latitude and

longitude. The values chosen for α_1 and α_2 were 34.0^o and 119.0^o for target area surfaces and 34.7^o and 120.3^o for control area surfaces. The estimates $b_{\ell k}$ of regression coefficients $\beta_{\ell k}$ $(0 \le \ell \le 3,\ 0 \le k \le 3 - \ell)$ were obtained using least square procedures.

Note that (8) differs from (5) in that fixed centering at α_1 and α_2, near the means of the corresponding variables, is used. This is more convenient for tabluation and future use.

The two main statistics obtained to evaluate the goodness of fit of cubic response surfaces were $100R^2$, the percentage of variation in original measurements explained by the fitted surface and the residual mean square error (MSE), the estimate of variability about the fitted surface. Table A-7 gives for target area surfaces values of (i) the number of stations in the band, (ii) the precipitation average for stations operative in the target region for the band, (iii) the sample variance, (iv) $100\ R^2$, the percentage variation explained by the fitted surface, (v) the MSE and (vi) the calculated value of the F-ratio*. The corresponding information for fitted surfaces in the control area is contained in Table A-8. The estimated regression coefficients $b_{\ell k}$ are listed by bands in Table A-9 for the target area and in Table A-10 for the control area.

Consider values of $100R^2$ for the target area in Table A-7.

---

*Under classical assumptions for regression models, F has the Snedecor variance-ratio distribution. While significance levels are referenced in these tables, validity of use is in question.

They broadly confirm the pattern observed in preliminary study of the test bands. The percentage of precipitation variation explained varies from a low of 13.8% for band 67 to a high of 84.1% attained by bands 11 and 12. There are as many as 32 bands for which the fitted surfaces did not account for even 40% of the variation in the original observations. On the other hand, 30 bands had values of $100R^2$ in excess of 60%. The performance of cubic response surfaces, as judged by the values of $100R^2$, can be considered to be fairly good.

It was conjectured that values of R^2 and MSE may be dependent on the magnitude of average band precipitation. There was no relationship whatsoever between R^2 and the simple average $\bar{y}$, but a strong relationship between $\bar{y}$ and MSE was evident.

The values of $100R^2$ for cubic surfaces in the control area are nearly all very high. Thus, data description by means of cubic response surfaces in the control area fitted well. This is reflected also in unusually small and almost constant values of MSE's (when rounded to two decimals places). But there are fewer raingage stations in the control area and some of the apparent goodness of fit is due to the large number of parameters estimated relative to the number of observations available. Again, there was a strong dependence of MSE's on the $\bar{y}$'s.

5.3 Volumes of Precipitation in Designated Geographical Areas. The objective of the response surface work was the summarization of band precipitation data. The summary measures to be used are the volumes of precipitation under the fitted response surfaces for designated geographical areas of interest.

We illustrate precipitation volume calculations through use of (8) and for rectangular areas with north-south, east-west orientations. Other areas may be used with only minor complications and may be used later. It is assumed that any area used is completely in either the target or control region and that the appropriate estimated surface from (8) is used. The estimated surface may be written,

$$\hat{y}(x_1, x_2) = b_{00} + b_{10}(x_1-\alpha_1) + b_{01}(x_2-\alpha_2) + b_{20}(x_1-\alpha_1)^2 + b_{11}(x_1-\alpha_1)(x_2-\alpha_2) + b_{02}(x_2-\alpha_2)^2 + b_{30}(x_1-\alpha_1)^3 + b_{21}(x_1-\alpha_1)^2(x_2-\alpha_2) + b_{12}(x_1-\alpha_1)(x_2-\alpha_2)^2 + b_{03}(x_2-\alpha_2)^3. \tag{9}$$

Let us assume that the precipitation volume V in inches of precipitation per degree of latitude by degree of longitude is required for the region, $a < x_1 < b$, $c < x_2 < d$ or for $\alpha < x_1-\alpha_1 < \beta$, $\gamma < x_2-\alpha_2 < \delta$, $\alpha = a-\alpha_1$, $\beta = b-\alpha_1$, $\gamma = c-\alpha_2$, $\delta = d-\alpha_2$. The precipitation volume is obtained by elementary integration as

$$V = b_{00}(\beta-\alpha)(\delta-\gamma) + b_{10}(\beta^2-\alpha^2)(\delta-\gamma)/2 + b_{01}(\beta-\alpha)(\delta^2-\gamma^2)/2 + b_{20}(\beta^3-\alpha^3)(\delta-\gamma)/3 + b_{11}(\beta^2-\alpha^2)(\delta^2-\gamma^2)/4 + b_{02}(\beta-\alpha)(\delta^3-\gamma^3)/3 + b_{30}(\beta^4-\alpha^4)(\delta-\gamma)/4 + b_{21}(\beta^3-\alpha^3)(\delta^2-\gamma^2)/6 + b_{12}(\beta^2-\alpha^2)(\delta^3-\gamma^3)/6 + b_{03}(\beta-\alpha)(\delta^4-\gamma^4)/4, \tag{10}$$

a linear function of the estimated regression coefficients. But the variances and covariances of these regression coefficients may be estimated and hence the estimated variance of V may be obtained.

Volumes and their variances were evaluated for each band for the following areas: (i) the complete target area, $34.0 < x_1 < 35.25$, $118.0 < x_2 < 120.02$, (ii) that portion of the target area in Santa Barbara County, $34.4 < x_1 < 35.0$, $119.51 < x_2 < 120.02$, (iii) that portion of the target area which enclosed

stations in most of Ventura and most of Los Angeles counties with $34.0 < x_1 < 35.0$, $118.0 < x_2 < 119.51$, (iv) the sum of areas defined in (ii) and (iii), and (v) the control area, $34.4 < x_1 < 35.25$, $120.02 < x_2 < 120.60$. The estimated volumes and their variances for the above five areas are presented in Table A-11. It should be pointed out here that target-area response surfaces were used for evaluations of the first four volumes, control-area surfaces were used for evaluations of volumes (v).

Estimates of volumes by bands were compared with simple averages[1] of raingage measurements from stations in the designated areas of interest. Table 6 shows values of the correlation

Table 6: CORRELATION COEFFICIENTS BETWEEN VOLUMES AND SIMPLE AVERAGES OF RAINGAGE MEASUREMENTS.

Geographical Areas	No. of Stations in the area	Corr. Coeff.	No. of Cases (bands)
(i) All Target $34.0 < x_1 < 35.25$ $118.0 < x_2 < 120.02$	107	0.9763	106
(ii) Santa Barbara $34.4 < x_1 < 35.0$ $119.51 < x_2 < 120.02$	26	0.9814	107
(iii) Ventura and LA $34.0 < x_1 < 35.0$ $118.0 < x_2 < 119.51$	72	0.9915	107
(iv) Santa Barbara, Ventura, and LA (ii) + (iii)	98	0.9943	107
(v) All Control $34.4 < x_1 < 35.25$ $120.02 < x_2 < 120.60$	34	0.8865	101

between volumes and simple averages for each of the five areas. Ideally, each correlation coefficient in the table should be based on 107 volume-average pairs corresponding to 107 bands. However, one band in the

[1]These averages and their variances are given in Table A-12.

target area and six bands in the control area had negative volumes and hence were deleted from the calculations. The negative parts of surfaces used were off the land area and redefinition of these regions will be necessary.

Table 6 shows that all correlation coefficients are very high. The implication of these high correlations is that the simple average of raingage measurements may be an adequate summary measure. Further analysis is likely to involve weighting of summary measures through use of their variances, whether or not there is advantage in use of precipitation volumes over simple averages may depend on the effects of weighting. Both types of measures will be considered in examination of the effects of cloud seeding. The investigators did judge that it was important to consider the possibility of more informative data summarization than the use of simple averages.

VI SUMMARY AND CONCLUSIONS

This report is on one of a series of investigations on summarization of data in weather modification experiments with particular reference to the Santa Barbara experiment. Summary measures of precipitation have been constructed using a two-stage procedure. In the first stage, response surfaces were fitted to raingage measurements for each experimental unit with raingage location coordinates as independent variables. In the second stage integrals of these surfaces were evaluated to obtain measures of total rainfall over designated areas for each experimental unit.

The method proposed is tested with data made available by North American Weather Consultants from Phase I of their Santa Barbara Convective Test Seeding Program. A review of these experiments and of reports [1, 4, 7] based on data generated from these experiments is contained in Sections II and III.

A pilot study with twelve selected bands was undertaken to determine the advantages and disadvantages of different functional forms of response surfaces. Details of this pilot study are reported in Section IV. It has been shown (Section 4.2) that appropriate response surfaces for Santa Barbara data are third degree polynomials in latitude and longitude of raingage locations. The cubic response surfaces did produce mean squared errors (MSE's) which were substantially smaller than the sample variances of the original observations (See Tables 4 and 5). The patterns of residuals from fitted surfaces were examined. It has been shown in Section 4.3 that distributions of residuals were non-normal. These distributions were usually right-skewed and leptokurtic. Section 4.3 also contains discussion on distributions of the original precipitation observations

and of two transforms of them. The precipitation observations had right-skewed and leptokurtic distributions. The two transformations used gave only marginal improvement in the shapes of distributions.

The cubic response surface fitting was extended to all the 107 experimental units and for target and control areas separately. These surfaces were integrated over designated areas of interest to produce total volumes of rainfall for those areas. The geographical areas considered were total target area, three subsets of the target area, and all of the control area. The variances of the computed volumes for each of these areas were obtained. Discussion on surface fitting and evaluation of volumes is given in Section V; tables of results are given in A-7 to A-11.

The percentages of variation explained by cubic response surfaces were moderately good in the target area and were excellent in the control area. Estimates of residual variances produced were substantially lower than the variances in the original data. Finally, estimates of volumes for selected geographical areas were found to be highly correlated with simple averages of raingage measurements in those areas. Both precipitation volumes and area averages will be used in further investigation. Primary use will be in association with concomitant variables in the evaluation of the effects of cloud seeding.

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OTHER TECHNICAL REPORTS ON THIS CONTRACT

Report Numbers	
M388, ONR-110	Hanson, Morgan, Bach, Charles L. and Cooley, Edward A., Bibliography of Statistical and Meteorological Methodology in Weather Modification, September, 1976.
M409, ONR-111	Bradley, Ralph A. & Srivastava, S.S., Correlation In Polynomial Regression, March, 1977.
M410, ONR-112	Bach, Charles L., An Interpretive History of 30-years (1945-1975) of Weather Modification, March, 1977.
M417, ONR-117	Bradley, Ralph A., Srivastava, S.S. and Lanzdorf, Adolf, Summarization of Precipitation Data In a Weather Modification Experiment: I. A Response Surface Approach, June, 1977.
M419, ONR-118	Gleeson, T.A., Data Summarization In a Weather Modification Experiment: II Concomitant Variables, June, 1977.
M420, ONR-119	Hanson, Morgan A., Rank Tests in Weather Modification Experiments, June, 1977.

APPENDICES

Part I: Figures

Part II: Tables

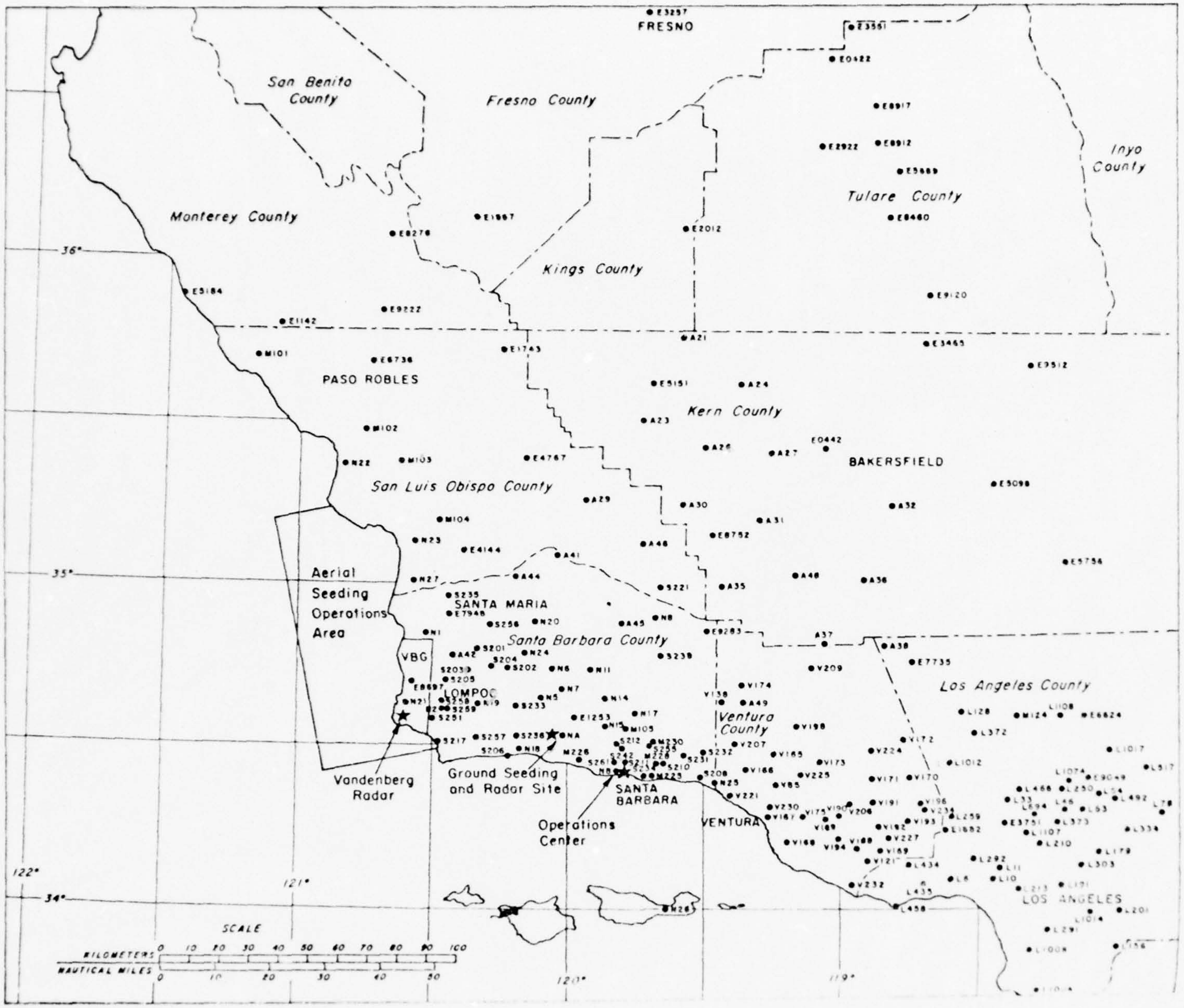

FIGURE A-1: PROJECT MAP SHOWING RAINGAGE LOCATIONS, RADAR, AND SEEDING SITES.
SOURCE: Page 2-14, [3].

FIGURE A-2: GEOGRAPHICAL DISTRIBUTION OF PRECIPITATION DATA: BAND 96, TARGET AREA.
(THE VERTICAL SCALE IS IN INCHES AND SHOWS DOUBLE THE ACTUAL PRECIPITATION).

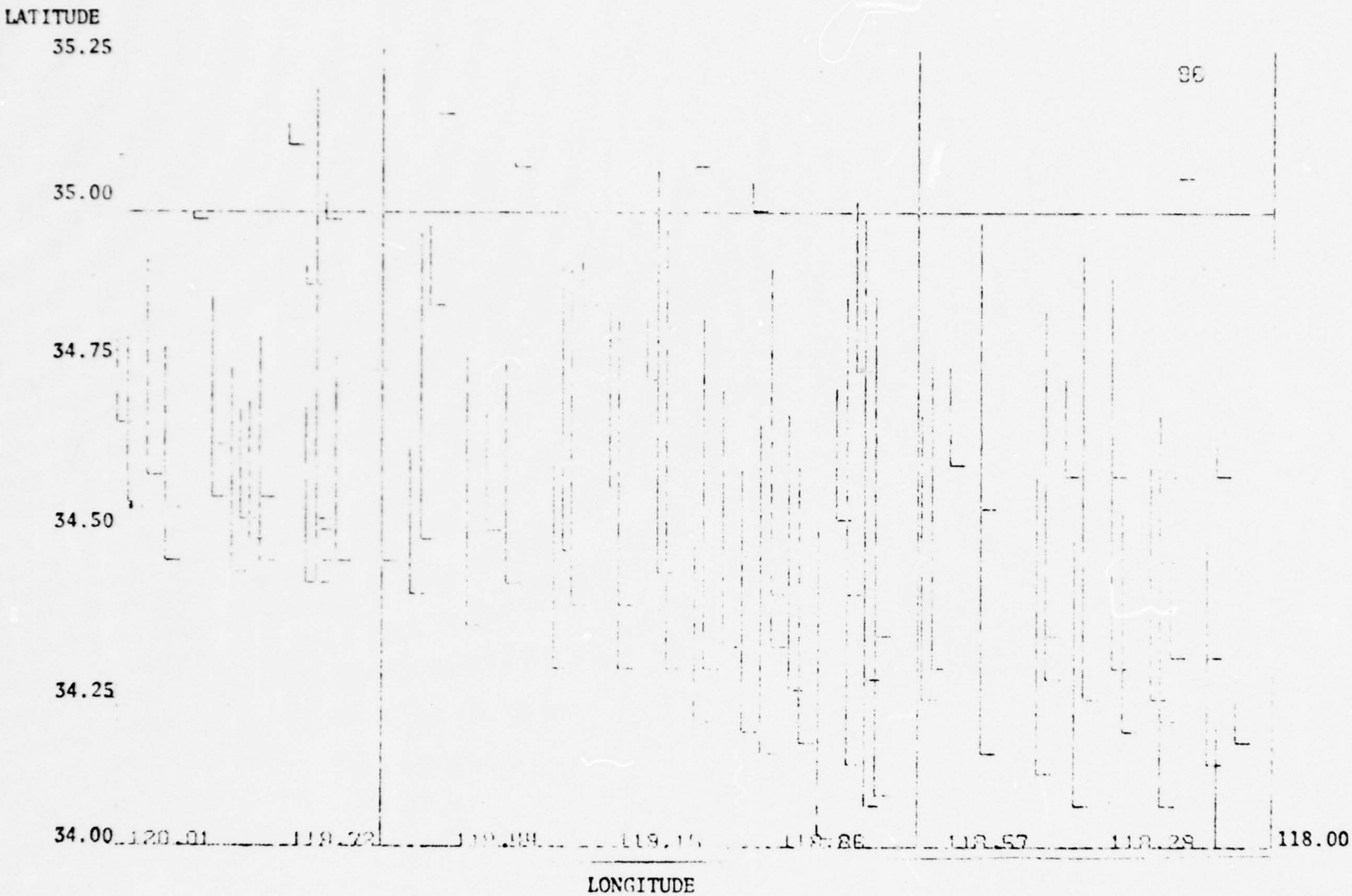

FIGURE A-3: GRAPH OF LINEAR RESPONSE SURFACE: BAND 96, TARGET AREA.
(VERTICAL AXIS MEASURES 2.3 TIMES THE PREDICTED PRECIPITATION IN INCHES).

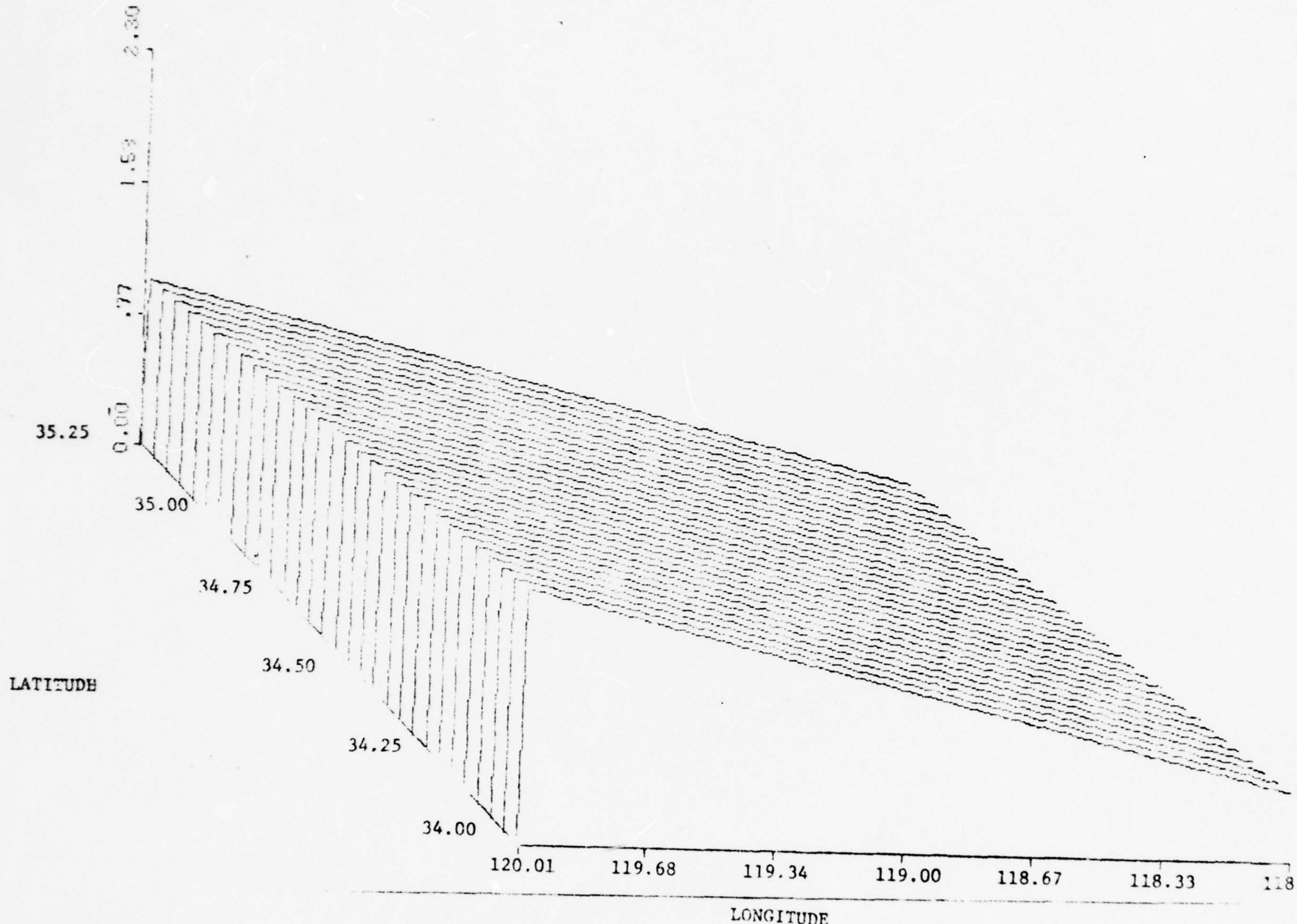

FIGURE A-4: GRAPH OF QUADRATIC RESPONSE SURFACE: BAND 96, TARGET AREA. (VERTICAL AXIS MEASURES 2.3 TIMES THE PREDICTED PRECIPITATION IN INCHES).

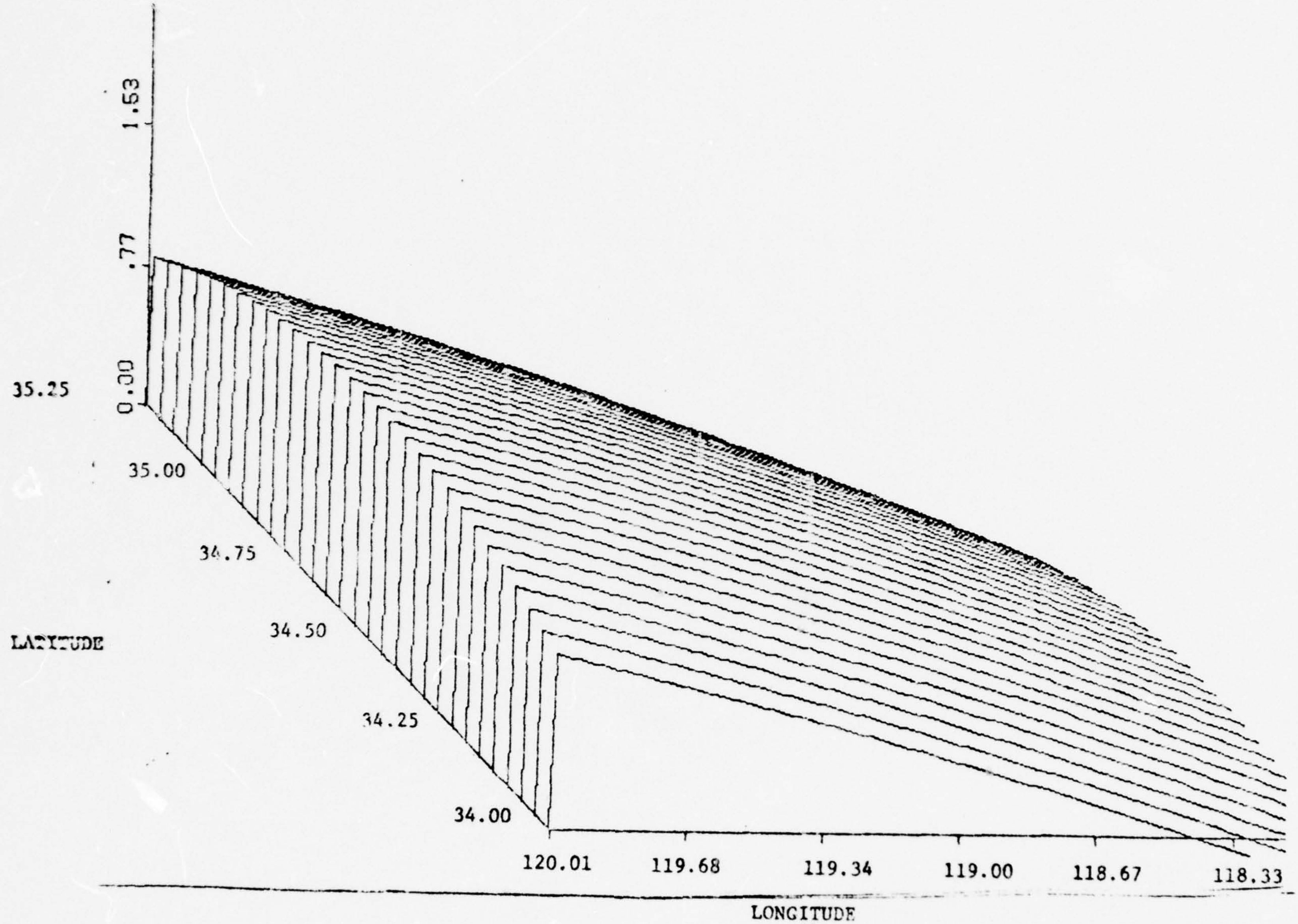

FIGURE A-5: GRAPH OF CUBIC RESPONSE SURFACE: BAND 96, TARGET AREA.
(VERTICAL AXIS MEASURES 2.3 TIMES THE PREDICTED PRECIPITATION IN INCHES).

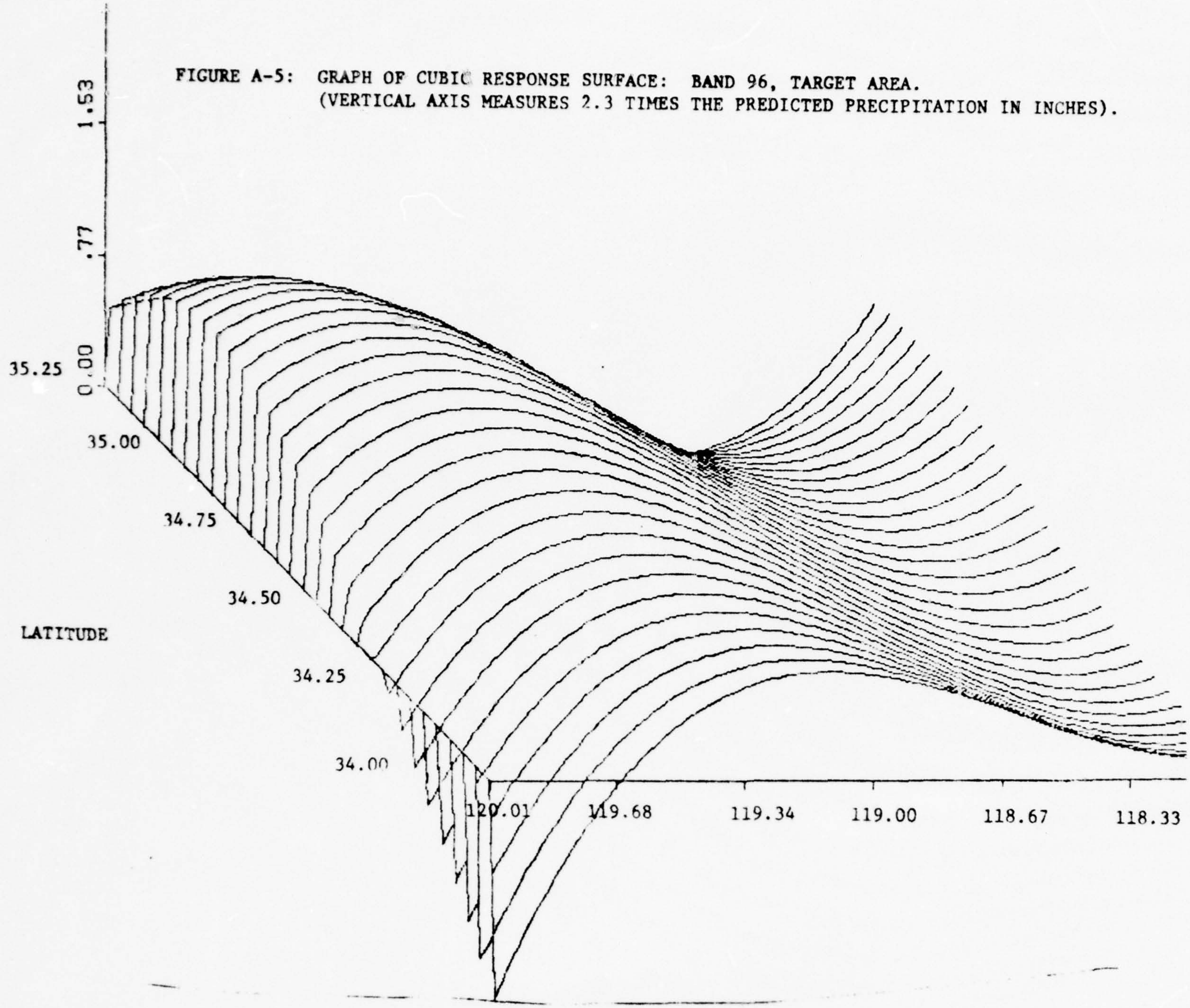

FIGURE A-6
GEOGRAPHICAL DISTRIBUTION OF RESIDUALS BY STATIONS FROM LINEAR RESPONSE SURFACE: BAND 96, TARGET AREA.
(THE VERTICAL SCALE IS IN INCHES AND SHOWS DOUBLE THE ACTUAL RESIDUAL).

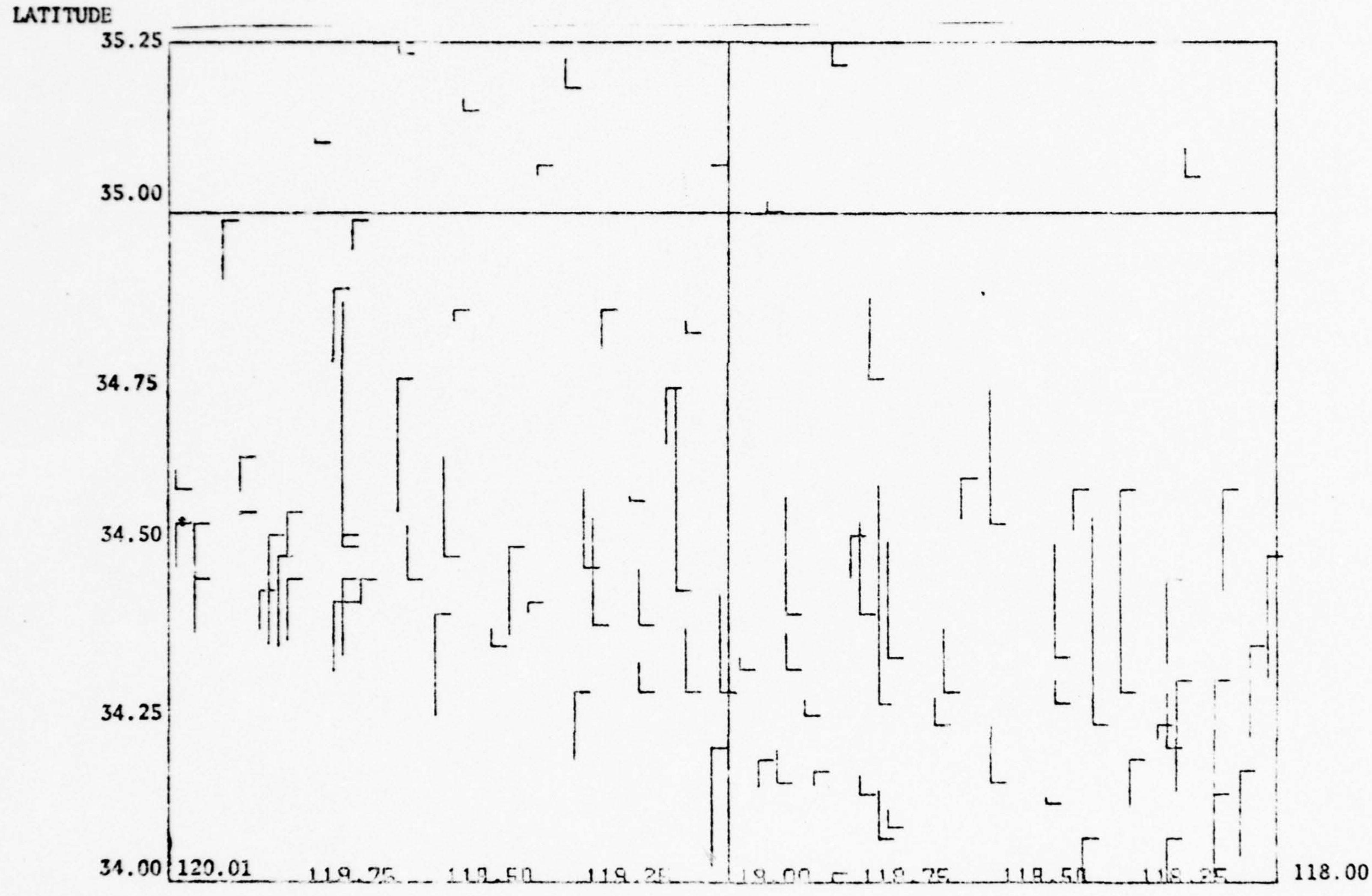

FIGURE A-7
GEOGRAPHICAL DISTRIBUTION OF RESIDUALS FROM QUADRATIC
RESPONSE SURFACE: BAND 96, TARGET AREA.
(THE VERTICAL SCALE IS IN INCHES AND SHOWS DOUBLE THE ACTUAL RESIDUAL).

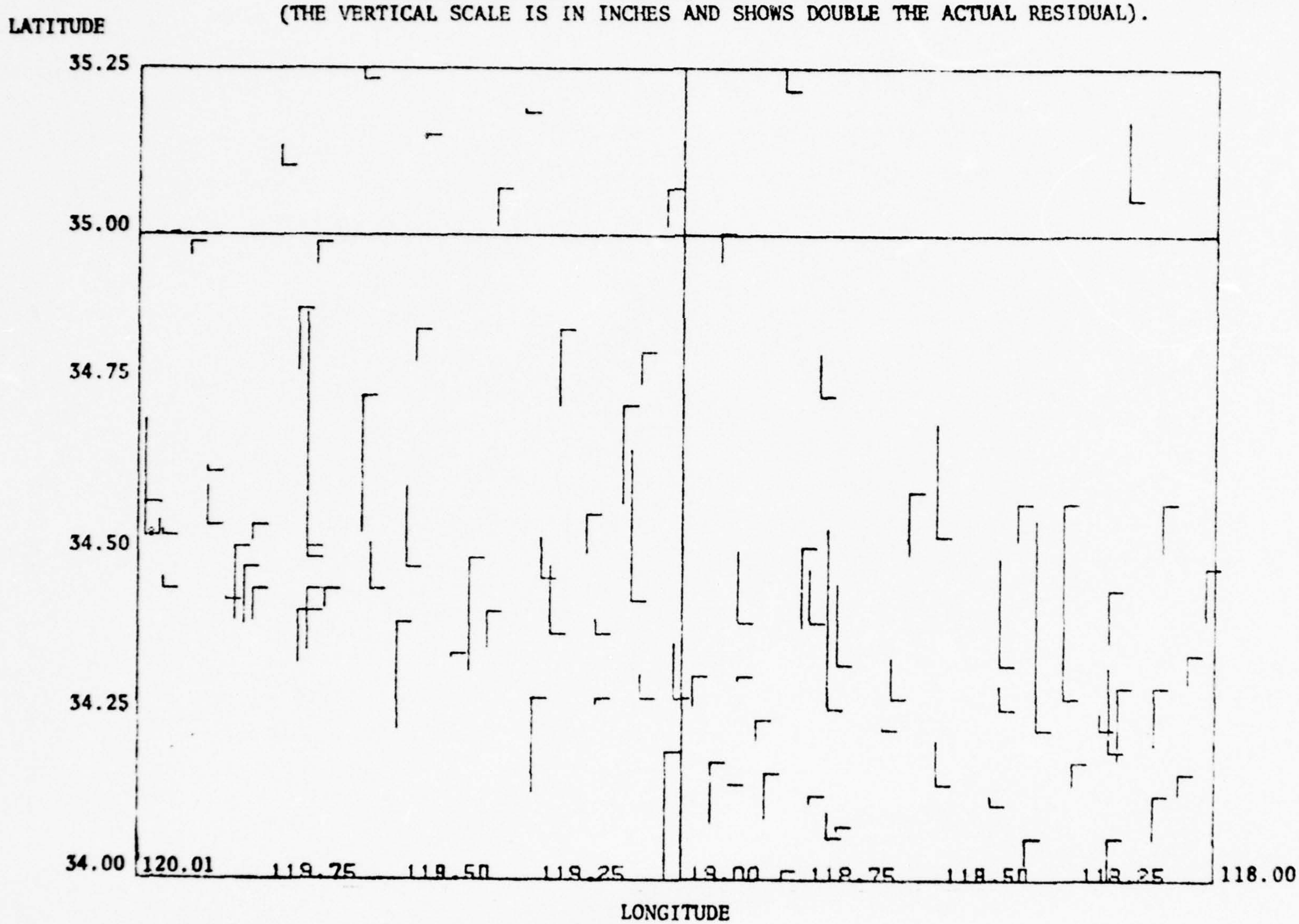

FIGURE A-8
GEOGRAPHICAL DISTRIBUTION OF RESIDUALS FROM CUBIC
RESPONSE SURFACE: BAND 96, TARGET AREA
(THE VERTICAL SCALE IS IN INCHES AND SHOWS DOUBLE THE ACTUAL RESIDUAL).

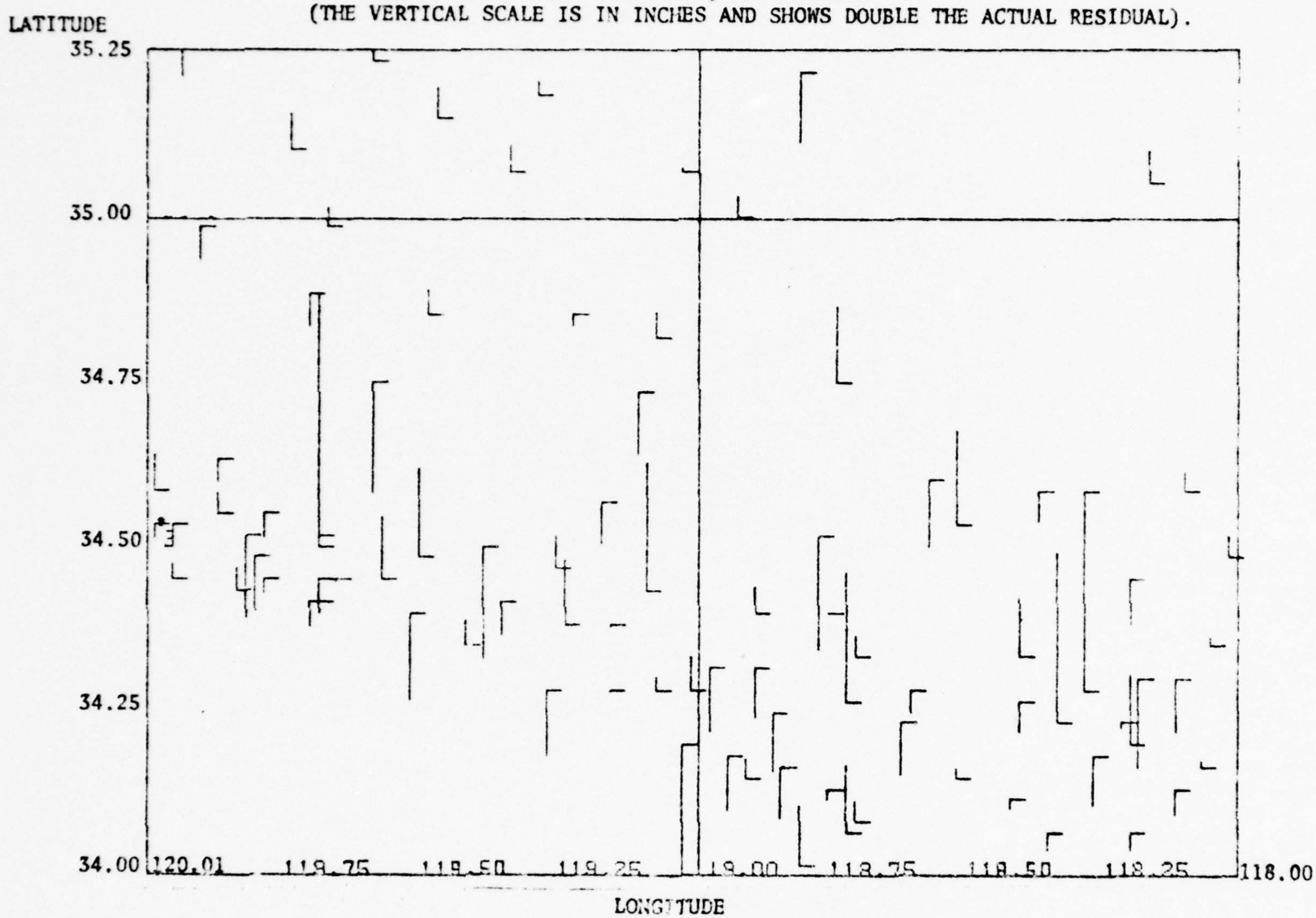

TABLE A-1: INDEX TO PRECIPITATION STATIONS IN TARGET AREA

Seq. No.	Station Code	Lat.	Long.	Alt. (m)
1	A 21	34.45	119.35	76.00
2	A 29	35.15	119.56	579.00
3	A 30	35.14	119.35	396.00
4	A 31	35.11	119.17	107.00
5	A 32	35.13	119.48	136.00
6	A 33	35.04	119.20	183.00
7	A 34	35.04	119.01	152.00
8	A 35	34.59	119.27	899.00
9	A 36	35.00	118.55	293.00
10	A 37	34.49	119.04	1890.00
11	A 38	34.28	118.51	1162.00
12	A 46	35.06	119.44	827.00
13	A 47	34.51	119.13	1829.00
14	E1253	34.35	119.59	238.00
15	E1682	34.14	118.37	276.00
16	E3751	34.16	118.24	335.00
17	E5756	35.03	118.10	834.00
18	E6624	34.35	118.06	791.00
19	E7735	34.45	118.44	1377.00
20	E8752	35.09	119.28	312.00
21	E9049	34.23	118.05	1416.00
22	E9283	34.51	119.29	638.00
23	E9459	34.59	119.54	723.00
24	L0010	34.05	118.27	178.00
25	L0011	34.07	118.25	264.00
26	L0033	34.20	118.24	457.00
27	L0046	34.18	118.11	706.00
28	L0053	34.18	118.07	1104.00
29	L0054	34.21	118.03	1719.00
30	L0128	34.36	118.34	633.00
31	L0178	34.10	118.04	360.00
32	L0191	34.04	118.12	122.00
33	L0210	34.11	118.16	381.00
34	L0213	34.04	118.21	53.00
35	L0250	34.27	118.12	800.00
36	L0259	34.17	118.36	389.00
37	L0292	34.09	118.31	328.00
38	L0303	34.05	118.07	244.00
39	L0372	34.32	118.31	482.00
40	L0377	34.14	118.13	673.00
41	L0434	34.08	118.45	244.00
42	L0435	34.05	118.42	183.00
43	L0453	34.01	118.48	35.00
44	L0465	34.21	118.21	962.00
45	L0694	34.17	118.17	465.00
46	L1014	34.00	118.06	52.00
47	L1017	34.29	118.01	1000.00
48	L1074	34.23	118.09	1707.00
49	L1107	34.14	118.20	354.00
50	L1108	34.35	118.17	877.00
51	L1181	34.20	118.27	1495.00
52	M 105	34.33	118.47	314.00
53	M 124	34.35	118.22	930.00

TABLE A-1: INDEX TO PRECIPITATION STATIONS IN TARGET AREA (Continued)

Seq. No.	Station Code	Lat.	Long.	Alt.(m)
54	M 225	34.25	119.41	2.00
55	M 226	34.27	119.57	34.00
56	M 228	34.27	119.41	262.00
57	M 230	34.31	119.41	473.00
58	N 03	34.53	119.42	884.00
59	N 11	34.44	119.55	927.00
60	N 13	34.32	119.57	1220.00
61	N 14	34.38	119.52	348.00
62	N 15	34.33	119.52	282.00
63	N 17	34.36	119.45	1183.00
64	N A	34.32	120.01	1067.00
65	N 3	34.26	119.50	3.00
66	S 208	34.24	119.31	3.00
67	S 210	34.27	119.39	166.00
68	S 211	34.27	119.47	122.00
69	S 212	34.31	119.49	762.00
70	S 221	34.59	119.40	362.00
71	S 231	34.27	119.34	427.00
72	S 232	34.29	119.30	633.00
73	S 234	34.25	119.42	24.00
74	S 236	34.47	119.39	1524.00
75	S 242	34.29	119.43	335.00
76	S 255	34.30	119.41	1067.00
77	V 085	34.23	119.14	335.00
78	V 121	34.09	118.54	308.00
79	V 138	34.34	118.76	1479.00
80	V 165	34.28	119.15	457.00
81	V 166	34.25	119.21	229.00
82	V 167	34.17	119.16	91.00
83	V 168	34.12	118.12	11.00
84	V 169	34.10	118.50	274.00
85	V 170	34.24	118.45	220.00
86	V 171	34.24	118.53	137.00
87	V 172	34.31	118.46	351.00
88	V 173	34.26	119.05	305.00
89	V 174	34.41	119.21	1091.00
90	V 175	34.17	119.09	46.00
91	V 188	[illegible]	118.56	194.00
92	V 189	34.17	119.04	139.00
93	V 190	34.17	119.00	168.00
94	V 191	34.19	118.53	183.00
95	V 192	34.15	118.51	168.00
96	V 193	34.16	118.43	293.00
97	V 194	34.12	119.01	37.00
98	V 196	34.20	118.42	457.00
99	V 198	34.34	119.16	1055.00
100	V 205	34.19	118.58	183.00
101	V 207	34.30	119.23	500.00
102	V 209	34.44	119.06	1570.00
103	V 221	34.21	119.25	3.00
104	V 224	34.29	118.53	701.00
105	V 225	34.23	119.09	213.00
106	V 227	34.15	118.50	314.00
107	V 232	34.04	118.43	1200.00

TABLE A-2: INDEX TO PRECIPITATION STATIONS IN CONTROL AREA

Seq. No.	Station Code	Lat.	Long.	Alt.(m)
1	A 41	35.05	120.03	595.30
2	A 42	34.46	120.26	95.00
3	A 44	35.01	120.12	305.00
4	E4144	35.06	120.23	218.00
5	E7946	34.54	120.27	72.00
6	E8697	34.41	120.34	34.00
7	N 100	34.38	120.21	39.00
8	M 104	35.11	120.29	165.00
9	N 01	34.50	120.32	91.00
10	N 02	34.37	120.28	98.00
11	N 03	34.45	120.17	177.00
12	N 04	34.36	120.12	104.00
13	N 05	34.39	120.07	238.00
14	N 06	34.44	120.05	375.00
15	N 07	34.40	120.02	137.00
16	N 18	34.29	120.12	53.00
17	N 19	34.37	120.20	67.00
18	N 20	34.53	120.08	262.00
19	N 21	34.39	120.36	67.00
20	S 201	34.47	120.20	195.00
21	S 202	34.44	120.14	220.00
22	S 203	34.44	120.22	305.00
23	S 204	34.45	120.17	172.00
24	S 205	34.41	120.27	91.00
25	S 206	34.28	120.14	9.00
26	S 215	34.39	120.28	29.00
27	S 217	34.30	120.29	6.00
28	S 233	34.37	120.12	114.00
29	S 235	34.57	120.27	61.00
30	S 236	34.32	120.11	201.00
31	S 249	34.54	120.04	953.00
32	S 251	34.35	120.30	341.00
33	S 256	34.52	120.17	134.00
34	S 257	34.32	120.20	195.00

TABLE A-3: INDEX TO PRECIPITATION STATIONS NOT INCLUDED IN THE STUDY

Seq. No.	Station Code	Lat.	Long.	Alt.(m)
1	A 23	35.30	119.43	213.00
2	A 24	35.37	119.22	101.00
3	A 26	35.25	119.30	81.00
4	A 27	35.24	119.15	107.00
5	A 45	34.53	119.49	1752.00
6	E0442	35.25	119.03	145.00
7	E1057	33.53	117.56	257.00
8	E1142	35.48	121.05	282.00
9	E1743	35.43	120.15	534.00
10	E3465	35.44	118.40	1067.00
11	E4767	35.27	120.10	473.00
12	E5098	35.18	118.26	829.00
13	E5114	33.56	118.24	105.00
14	E5151	35.37	119.41	87.00
15	E5184	35.53	121.27	108.00
16	E6006	34.14	118.04	1741.00
17	E6736	35.41	120.45	317.00
18	E7779	34.12	117.52	1481.00
19	E7926	37.07	117.58	427.00
20	E8230	33.46	118.10	100.00
21	E8436	34.03	117.49	676.00
22	E6832	35.08	118.26	1207.00
23	E9222	35.50	120.42	250.00
24	E9512	35.40	118.18	817.00
25	L0006	34.95	118.36	227.00
26	L0078	34.17	117.50	1000.00
27	L0156	33.53	118.00	26.00
28	L0201	33.59	117.59	258.00
29	L0291	33.57	118.15	37.00
30	L0374	34.14	117.57	701.00
31	L0492	34.19	118.00	1610.00
32	L0517	34.25	117.53	1407.00
33	L1006	33.44	118.18	46.00
34	L1008	33.52	118.20	65.00
35	M 101	35.41	121.10	442.00
36	M 102	35.26	120.46	427.00
37	M 103	35.22	120.38	320.00

TABLE A-4: VARIANCE AND SHAPE STATISTICS FOR PRECIPITATIONS FROM SELECTED BANDS

	Target Area			Control Area		
Band No.	Variance	Skewness	Kurtosis	Variance	Skewness	Kurtosis
1	.005	1.850	4.458	.011	0.801	-0.913
2	.008	1.912	4.779	.008	0.043	-0.992
3	.010	2.251	7.123	.003	0.621	-0.250
4	.001	1.362	2.563	.001	-0.171	-0.685
5	.008	0.390	0.768	.008	0.108	-0.720
7	.003	2.048	4.845	.005	0.818	0.675
94	.001	1.472	1.290	.003	0.420	-0.834
95	.013	0.715	0.047	.013	2.085	5.099
96	.178	-0.031	-0.935	.057	1.267	1.996
97	.140	0.687	-0.657	.042	1.799	3.989
98	.008	1.548	2.678	.002	0.321	-0.807
99	.180	0.770	1.163	.032	1.483	3.466

TABLE A-5: VARIANCE AND SHAPE STATISTICS FOR $Z = \log[1 + \log(1+Y)]$ FOR SELECTED BANDS

	Target Area			Control Area		
Band No.	Variance	Skewness	Kurtosis	Variance	Skewness	Kurtosis
1	.003	1.387	2.243	.007	0.690	-1.083
2	.004	1.362	2.131	.003	-0.147	-0.938
3	.004	1.482	3.453	.002	0.431	-0.531
4	.001	1.126	1.658	.001	-0.287	-0.716
5	.005	-0.093	-0.053	.005	-0.163	-0.772
7	.002	1.725	3.147	.003	0.480	0.232
94	.001	1.396	0.989	.003	0.277	-1.042
95	.007	0.358	-0.726	.006	1.459	2.316
96	.038	-0.664	-0.729	.018	0.454	-0.330
97	.035	0.150	-1.174	.012	0.864	1.027
98	.005	1.102	1.137	.001	0.203	-0.852
99	.022	-0.481	0.362	.004	0.794	1.145

TABLE A-6: VARIANCE AND SHAPE STATISTICS FOR RESIDUALS FROM CUBIC SURFACES FOR SELECTED BANDS

	Target Area			Control Area		
Band No.	Variance	Skewness	Kurtosis	Variance	Skewness	Kurtosis
1	.003	1.680	5.392	.003	-0.581	0.783
2	.004	1.286	5.461	.002	-0.540	0.561
3	.008	2.312	7.457	.000	0.216	0.734
4	.001	1.584	4.559	.000	1.367	2.187
5	.004	0.630	3.324	.001	0.137	-0.904
7	.001	1.619	6.898	.001	-0.312	-0.713
94	.000	0.872	1.355	.002	0.279	0.539
95	.005	1.478	4.422	.005	3.089	13.348
96	.044	0.864	1.889	.012	0.811	0.136
97	.050	0.496	1.058	.018	2.601	9.755
98	.005	1.467	2.419	.001	0.889	0.313
99	.098	0.798	1.742	.023	1.123	1.795

TABLE A-7: PRECIPITATION AND CUBIC RESPONSE SURFACE STATISTICS, TARGET AREA

Band No.	No. of Stations, n	Mean Precip. $\bar{y}$	Precip. Var. s^2	$100R^2$	MSE	F^1
1	75	.0637	.0048	45.2	.00302	5.9064
2	75	.1028	.0078	49.3	.00451	7.0246
3	75	.1665	.0099	15.5	.00949	1.3210
4	75	.0376	.0012	27.1	.00096	2.6787
5	84	.1527	.0082	57.0	.00397	10.8877
6	84	.0392	.0027	41.2	.00181	5.7678
7	68	.0352	.0026	50.9	.00142	8.9703
8	83	.0022	.0001	36.7	.00004	4.7014
9	83	.0075	.0003	63.6	.00014	14.1623
10	83	.0146	.0003	54.3	.00017	9.6416
11	83	.1134	.0130	84.1	.00231	42.9681
12	83	.1482	.0163	84.1	.00291	42.7867
13	83	.0358	.0018	64.0	.00074	14.4431
14	82	.0299	.0026	68.7	.00091	17.5228
15	82	.3682	.0544	28.6	.04371	3.1974
16	82	.0857	.0088	34.4	.00652	4.1959
17	85	.3433	.0568	78.9	.01339	31.2493
18	79	.0606	.0063	55.7	.00316	9.6238
19	81	.5642	.1054	35.1	.07703	4.2697
20	81	.0336	.0023	51.6	.00123	8.4164
21	81	.0868	.0071	14.2	.00687	1.3060
22	81	.0367	.0016	40.8	.00110	5.4312
23	69	.0959	.0041	72.1	.00132	16.9629
24	69	.1094	.0048	66.1	.00178	12.7843
25	68	.0547	.0017	57.1	.00085	8.5667
26	69	.0577	.0031	36.7	.00223	3.8057
27	75	.0091	.0002	27.8	.00019	2.7760
28	75	.1267	.0104	50.6	.00586	7.4044
29	79	.0094	.0007	65.2	.00026	14.3497
30	81	.1625	.0093	56.5	.00456	10.2636

Footnote: [1]Significance probabilities of F-ratios can be approximated from the standard F-table with 9 and (n-10) degrees of freedom.

TABLE A-7: PRECIPITATION AND CUBIC RESPONSE SURFACE STATISTICS, TARGET AREA (CONTINUED)

Band No.	No. of Stations, n	Mean Precip. $\bar{y}$	Precip. Var. s^2	$100R^2$	MSE	F^1
31	84	.0127	.0005	17.8	.00043	1.7841
32	84	.0224	.0011	35.8	.00077	4.5846
33	88	.0522	.0034	62.5	.00142	14.4713
34	89	.3091	.0235	64.6	.00928	16.0160
35	89	.2360	.0172	44.8	.01059	7.1154
36	89	.0640	.0040	49.7	.00225	8.6699
37	92	.2126	.0164	55.6	.00808	11.4235
38	93	.1735	.0575	48.6	.03276	8.7210
39	92	.2462	.0953	45.8	.05730	7.7047
40	89	.4562	.1587	44.7	.09765	7.0828
41	90	.1968	.0273	52.4	.01442	9.8040
42	90	.5890	.2224	67.6	.08023	18.5242
43	91	.4399	.1469	46.2	.08790	7.7143
44	90	.6224	.4163	38.2	.28611	5.4992
45	91	.5955	.1810	43.1	.11446	6.8103
46	93	.1911	.0099	66.2	.00372	18.0922
47	92	.0637	.0022	34.0	.00161	4.7029
48	92	.1911	.0162	59.0	.00739	13.0961
49	92	.1796	.0084	44.6	.00519	7.3425
50	82	.0372	.0018	60.4	.00079	12.1920
51	87	.0390	.0026	63.7	.00105	15.0222
52	88	.2257	.0390	72.5	.01197	22.8657
53	88	.1972	.0124	32.9	.00930	4.2557
54	87	.4887	.0440	65.6	.01689	16.3466
55	88	.1197	.0086	43.2	.00544	6.6033
56	88	1.2920	.4311	47.2	.25397	7.7429
57	87	.2910	.1093	30.3	.08505	3.7241
58	87	.2128	.0419	22.8	.03611	2.5327
59	87	.9720	.3135	20.4	.27857	2.1978
60	86	.0960	.0069	28.0	.00718	3.2774

TABLE A-7: PRECIPITATION AND CUBIC RESPONSE SURFACE STATISTICS, TARGET AREA (CONTINUED)

Band No.	No. of Stations, n	Mean Precip. $\bar{y}$	Precip. Var. s^2	$100R^2$	MSE	F^1
61	91	.0781	.0088	67.7	.00317	18.8738
62	91	.4371	.1086	66.6	.04026	17.9673
63	91	.2502	.0401	60.6	.01758	13.8214
64	80	.1807	.0754	64.8	.02997	14.2912
65	81	.1702	.0263	58.6	.01228	11.1783
66	94	.0161	.0009	76.5	.00024	30.4569
67	87	.0272	.0010	13.8	.00098	1.3667
68	86	.2014	.0449	56.3	.02195	10.3936
69	87	.1323	.0135	27.4	.01091	3.2299
70	91	.0187	.0004	25.8	.00036	3.1336
71	90	.0932	.0048	48.1	.00275	8,2315
72	90	.0622	.0027	65.8	.00104	17.1197
73	91	.0629	.0024	63.1	.00100	15.4036
74	91	.1170	.0041	38.9	.00280	5.7201
75	96	.5473	.0535	55.5	.02532	11.9003
76	93	.0194	.0012	56.8	.00058	12.1218
77	93	.4737	.1217	51.8	.05506	9.9042
78	93	.3176	.0448	33.0	.03324	4.5472
79	95	.3446	.0778	53.3	.04016	10.7997
80	96	.1193	.0295	14.8	.02780	1.6643
81	96	.2578	.0224	30.3	.01722	4.1631
82	94	.0588	.0057	21.1	.00498	2.4945
83	94	.1205	.0297	23.0	.02533	2.7916
84	93	.2709	.0308	44.7	.01888	7.4540
85	94	.9040	.1906	57.5	.08971	12.6234
86	86	.1006	.0059	64.2	.00234	15.1757
87	90	.0579	.0038	43.4	.00238	6.8263
88	90	.0801	.0126	26.0	.01036	3.1275
89	96	.0316	.0074	33.1	.00252	4.7303
90	96	.2110	.0236	68.0	.00836	20.2723

TABLE A-7: PRECIPITATION AND CUBIC RESPONSE SURFACE STATISTICS, TARGET AREA (CONTINUED)

Band No.	No. of Stations, n	Mean Precip. $\bar{y}$	Precip. Var. s^2	$100R^2$	MSE	F[1]
91	94	1.0084	.3666	41.5	.23737	6.6270
92	92	.6492	.2032	58.7	.09304	12.9739
93	91	.2063	.0284	45.4	.01723	7.4784
94	91	.0170	.0006	57.6	.00029	12.2083
95	94	.1328	.0129	59.3	.00580	13.6178
96	93	.6634	.1783	75.6	.04825	28.5423
97	93	.4362	.1397	64.2	.05536	16.5645
98	93	.0940	.0077	36.4	.00542	5.2837
99	92	.8258	.1800	45.4	.10916	7.5645
100	89	.1082	.0079	22.4	.00685	2.5288
101	88	.0542	.0020	29.8	.00160	3.6767
102	89	.0562	.0017	49.2	.00097	8.4993
103	95	.1838	.0258	42.7	.01632	7.0416
104	94	.0783	.0077	55.4	.00382	11.6147
105	89	.4610	.0693	52.2	.03689	9.5975
106	85	.1824	.0166	65.0	.00650	15.4504
107	85	.2741	.0396	77.7	.00987	29.0768

TABLE A-8: PRECIPITATION AND CUBIC RESPONSE SURFACE STATISTICS, CONTROL AREA

Band No.	No. of Stations, n	Mean Precip. $\bar{y}$	Precip. Var. s^2	$100R^2$	MSE	F[1]
1	15	.1013	.0109	74.7	.00771	1.6435
2	15	.2540	.0078	70.2	.00647	1.3105
3	16	.0300	.0033	91.4	.00071	7.0945
4	16	.0563	.0012	88.6	.00034	5.2018
5	16	.1450	.0084	93.3	.00141	9.2296
6	16	.0975	.0039	85.9	.00136	4.0593
7	16	.1125	.0048	86.0	.00168	4.0977
8	19	.0058	.0001	57.5	.00006	1.3520
9	19	.0105	.0002	69.8	.00011	2.3136
10	19	.0342	.0005	85.1	.00015	5.6901
11	19	.1800	.0029	79.7	.00118	3.9241
12	19	.2795	.0114	91.9	.00185	11.2849
13	19	.0784	.0045	84.5	.00141	5.4436
14	19	.1000	.0040	55.3	.00357	1.2377
15	17	.1594	.0073	77.5	.00377	2.6856
16	17	.1229	.0034	62.8	.00288	1.3131
17	20	.8920	.0360	53.8	.03162	1.2940
18	18	.2393	.0057	75.5	.00295	2.7320
19	16	.5481	.0331	78.6	.01767	2.4542
20	16	.0375	.0021	64.4	.00189	1.2074
21	17	.0847	.0103	76.4	.00556	2.5163
22	17	.1059	.0028	91.0	.00057	7.8843
23	23	.2365	.0042	50.5	.00353	1.4723
24	23	.1883	.0028	55.7	.00213	1.8150
25	23	.0870	.0015	81.9	.00045	6.5238
26	23	.0904	.0040	64.1	.00243	2.5735
27	23	.1039	.0057	91.4	.00082	15.4134
28	23	.1570	.0066	77.2	.00255	4.8916
29	23	.1330	.0059	75.1	.00250	4.3528
30	22	.2582	.0142	88.1	.00297	9.8482

Footnote: [1]Significance probabilities of F-ratios can be approximated from the standard F-table with 9 and (n-10) degrees of freedom.

TABLE A-8: PRECIPITATION AND CUBIC RESPONSE SURFACE STATISTICS, CONTROL AREA (CONTINUED)

Band No.	No. of Stations, n	Mean Precip. $\bar{y}$	Precip. Var. s^2	$100R^2$	MSE	F^1
31	23	.1100	.0046	82.0	.00141	6.5955
32	23	.0326	.0003	47.7	.00025	1.3152
33	23	.1217	.0130	72.5	.00606	3.8162
34	23	.2743	.0048	70.3	.00239	3.4250
35	23	.1709	.0028	70.7	.00138	3.4938
36	23	.1083	.0022	37.7	.00231	.8733
37	22	.2364	.0062	71.0	.00317	3.2635
38	22	.2355	.0674	92.6	.00873	16.6791
39	22	.4236	.0869	65.6	.05234	2.5410
40	21	.3338	.0418	87.9	.00919	8.8903
41	21	.1433	.0108	69.0	.00608	2.7158
42	21	.3100	.0166	76.9	.00697	4.0752
43	20	.6280	.0413	63.2	.02886	1.9122
44	19	.4463	.0272	54.2	.02492	1.1823
45	19	.1779	.0130	74.8	.00653	2.9734
46	23	.1035	.0092	78.4	.00335	5.2523
47	24	.0317	.0018	88.3	.00034	11.7033
48	23	.1430	.0025	61.1	.00164	2.2670
49	23	.2017	.0125	90.7	.00196	14.1442
50	22	.1495	.0045	86.3	.00109	8.3912
51	20	.0635	.0016	84.8	.00047	6.2201
52	20	.3635	.0927	75.1	.04382	3.3559
53	21	.1952	.0057	94.2	.00060	19.7731
54	22	.4600	.0170	66.6	.00993	2.6623
55	22	.1155	.0047	42.0	.00472	.9660
56	22	.7714	.1203	46.4	.11275	1.1556
57	22	.3414	.0621	78.5	.02335	4.8723
58	22	.1873	.0119	90.3	.00203	12.3481
59	22	.6955	.0484	62.9	.03141	2.2654
60	22	.0927	.0018	83.0	.00049	6.5150

TABLE A-8: PRECIPITATION AND CUBIC RESPONSE SURFACE STATISTICS, CONTROL AREA (CONTINUED)

Band No.	No. of Stations, n	Mean Precip. $\bar{y}$	Precip. Var. s^2	$100R^2$	MSE	F^1
61	21	.1700	.0145	70.7	.00772	2.9436
62	22	.4745	.0738	62.2	.04878	2.1952
63	22	.4318	.0186	54.0	.01496	1.5643
64	23	.4691	.0472	73.1	.02150	3.9192
65	25	.3996	.0298	77.7	.01063	5.8154
66	25	.0872	.0076	87.3	.00154	11.5002
67	25	.0356	.0013	79.5	.00042	6.4707
68	25	.2820	.0165	81.1	.00498	7.1477
69	24	.2096	.0087	53.3	.00666	1.7775
70	25	.0452	.0009	27.7	.00109	.5391
71	25	.2392	.0132	61.7	.00812	2.6841
72	24	.1538	.0025	75.4	.00100	4.7509
73	24	.1400	.0032	60.1	.00208	2.3388
74	24	.1467	.0112	79.1	.00383	5.8993
75	25	.0744	.0070	87.7	.00137	11.9371
76	26	.0865	.0041	32.9	.00428	.8723
77	28	.2854	.0379	84.0	.00308	10.5118
78	28	.4679	.0790	84.6	.01828	10.9586
79	28	.4246	.0153	33.8	.01522	1.0210
80	28	.1914	.0183	71.2	.00791	4.9429
81	28	.1039	.0052	79.0	.00163	7.5411
82	26	.1304	.0120	53.4	.00872	2.0348
83	26	.1115	.0130	47.4	.01070	1.6020
84	26	.1412	.0064	69.1	.00309	3.9755
85	27	.3248	.0497	52.8	.03585	2.1148
86	24	.2329	.0224	93.0	.00258	20.6422
87	26	.1254	.0169	84.2	.00417	9.4626
88	26	.1165	.0051	52.8	.00374	1.9874
89	28	.0925	.0110	55.1	.00579	3.7233
90	26	.0473	.0048	74.6	.00192	5.2306

TABLE A-8: PRECIPITATION AND CUBIC RESPONSE SURFACE STATISTICS, CONTROL AREA (CONTINUED)

Band No.	No. of Stations, n	Mean Precip. $\bar{y}$	Precip. Var. s^2	$100R^2$	MSE	F^1
91	24	.3821	.0556	60.7	.03590	2.4058
92	24	.1550	.0150	74.0	.00642	4.4179
93	28	.2636	.0415	38.2	.03843	1.2360
94	28	.0593	.0034	35.5	.00331	1.1017
95	33	.1133	.0125	60.6	.00686	3.9344
96	33	.3024	.0553	79.6	.01572	9.9459
97	33	.2806	.0409	56.8	.02458	3.3644
98	33	.0652	.0018	16.4	.00187	.5019
99	32	.0828	.0305	25.8	.03190	.8510
100	33	.1039	.0030	81.2	.00079	11.0096
101	33	.1252	.0023	53.2	.00150	2.9058
102	34	.0694	.0012	50.4	.00085	2.7086
103	29	.1455	.0160	55.6	.01044	2.6425
104	29	.0714	.0097	61.9	.00545	3.4274
105	31	.5019	.0331	45.3	.02562	1.9335
106	25	.3232	.0088	69.5	.00428	3.7919
107	24	.3438	.0153	45.3	.01376	1.2857

TABLE A-9: ESTIMATES OF COEFFICIENTS OF CUBIC REGRESSIONS, TARGET AREA

Band No.	b_{00}	b_{10}	b_{01}	b_{20}	b_{11}	b_{02}	b_{30}	b_{21}	b_{12}	b_{03}
1	1.0935E-01	-5.1137E-01	4.1503E-01	1.5146E+00	-1.2412E+00	3.4859E-01	-1.0199E+00	9.8661E-01	-7.7481E-01	4.3319E-03
2	-5.1402E-02	7.7801E-01	-5.1052E-01	-1.4620E+00	2.5088E+00	-4.0039E-01	8.4181E-01	-2.4220E+00	1.0543E+00	-1.0014E-01
3	2.8268E-02	4.9776E-01	-6.3454E-02	-2.0335E-01	2.1173E-01	3.8579E-02	-2.4083E-01	-7.5197E-02	-7.4891E-02	-5.4336E-02
4	-2.8334E-02	2.1696E-01	-1.0565E-01	-1.0336E-01	2.3515E-01	-2.3636E-02	-7.5018E-02	-1.2940E-01	7.4402E-02	3.7654E-02
5	-6.4201E-02	1.9164E+00	-4.6926E-01	-3.8429E+00	1.0945E+00	-3.2279E-01	1.8886E+00	-6.4050E-01	5.4005E-01	1.6059E-01
6	-1.4141E-02	2.2140E-01	1.5151E-02	-1.8586E-01	1.6758E-01	3.0898E-02	2.2421E-02	-1.5693E-01	-6.4611E-02	-1.0735E-02
7	1.7203E-02	-1.8988E-01	2.7151E-02	7.3421E-01	-1.4020E-01	1.0465E-01	-4.7393E-01	4.4160E-02	-1.5763E-01	9.8561E-02
8	-5.6831E-03	1.0341E-02	-2.1845E-02	4.4768E-02	8.4502E-02	-1.8594E-02	-4.9470E-02	-5.0046E-02	2.8949E-02	-8.2227E-03
9	1.0822E-02	-1.9591E-01	4.1027E-03	6.5112E-01	-7.5597E-02	2.4504E-02	-4.0037E-01	4.0731E-02	-9.6955E-02	2.1436E-02
10	4.6088E-02	-1.2049E-01	8.0004E-02	9.1244E-02	-1.5837E-01	1.3808E-02	-2.1547E-02	1.0122E-01	1.0491E-02	-1.0459E-02
11	4.1826E-02	6.5642E-01	1.2957E-01	-1.1993E+00	6.6123E-01	-8.6880E-02	4.8101E-01	-6.3308E-01	1.5006E-01	-1.9526E-01
12	2.7976E-01	-2.2153E-01	3.4554E-01	-3.2315E-01	-3.7368E-01	2.3031E-01	3.0973E-01	-1.7840E-02	-1.6228E-01	8.4270E-02
13	2.8977E-02	-6.5289E-02	1.6100E-01	1.1581E-01	-4.0026E-01	1.3837E-01	-2.7880E-02	2.0549E-01	-2.4710E-01	4.7045E-02
14	-2.3952E-02	1.1428E-01	-4.6528E-02	-2.6841E-02	3.0892E-01	2.0281E-02	-8.2141E-02	-2.3985E-01	6.5875E-02	2.2028E-02
15	5.1948E-02	2.4536E+00	-4.9445E-01	-5.5372E+00	2.0399E+00	-1.2980E-01	2.8978E+00	-1.3005E+00	3.6845E-01	-1.4731E-01
16	-1.3372E-01	1.2925E+00	-4.9796E-01	-1.9923E+00	1.3703E+00	-7.1771E-01	7.5288E-01	-8.4983E-01	5.5911E-01	1.1485E-01
17	2.4676E-01	5.7717E-01	-1.9704E-02	-1.5246E+00	1.8583E-01	4.0301E-01	8.4575E-01	-3.4478E-01	-3.9334E-01	5.6715E-01
18	-7.4264E-02	5.8214E-01	-2.7914E-01	-1.0027E+00	4.7926E-01	5.0290E-02	4.5209E-01	-3.0163E-01	8.4207E-02	2.4797E-01
19	-7.6756E-02	3.3768E+00	-4.5329E-01	-4.9535E+00	2.4167E+00	2.3798E-01	1.8984E+00	-2.0193E+00	-3.6086E-01	4.0040E-02
20	-4.3586E-02	1.7171E-01	-1.1995E-01	2.0412E-01	4.3923E-01	-9.8772E-02	-3.0904E-01	-2.2650E-01	1.6528E-01	-3.2892E-02
21	-6.5511E-02	1.0479E+00	-1.9714E-01	-1.7493E+00	7.8918E-01	-1.4456E-01	7.3967E-01	-5.2756E-01	1.9124E-01	-9.1110E-02
22	1.4315E-02	1.5477E-01	-4.6720E-03	-4.2927E-01	1.7670E-02	-4.3019E-02	1.8109E-01	7.2422E-02	2.4110E-01	-2.2641E-02
23	2.3632E-02	1.8260E-01	-7.8873E-02	-1.1406E-01	4.8165E-01	-7.5243E-02	-9.2174E-02	-2.7872E-01	2.5391E-01	-4.1490E-02
24	5.5316E-02	2.7485E-01	-6.9640E-02	-4.3865E-01	4.6225E-01	-1.6462E-01	5.7517E-02	-2.1574E-01	4.2680E-01	-7.4911E-02
25	-2.2306E-02	4.4363E-01	-9.3979E-02	-7.4199E-01	5.1345E-01	-7.4560E-02	3.9571E-01	-4.2991E-01	1.0964E-01	-1.4847E-02
26	-1.7282E-02	5.1967E-01	-1.9673E-01	-7.7971E-01	7.2852E-01	-2.2848E-01	2.2565E-01	-4.5839E-01	3.8110E-01	-2.4091E-02
27	3.1377E-02	-1.0514E-01	1.7294E-02	1.2532E-01	-2.5222E-02	-4.2138E-03	-5.3127E-02	1.0340E-02	2.3477E-02	6.8135E-03
28	1.7909E-02	6.2590E-01	-1.1303E-01	-1.2615E+00	3.8231E-01	6.9857E-02	5.9072E-01	-2.9577E-01	6.0825E-02	1.2550E-01
29	-3.0110E-02	1.2132E-01	-1.0237E-01	-1.4997E-01	3.1804E-01	-4.4140E-02	5.3045E-02	-2.3401E-01	1.4017E-01	3.2319E-02
30	-3.5500E-02	9.7796E-01	-4.5680E-02	-1.8327E+00	4.0437E-01	2.0305E-01	9.9389E-01	-2.7815E-01	-1.8633E-01	2.9403E-02
31	-2.5489E-02	2.2062E-01	-3.3872E-02	-3.0836E-01	1.3595E-01	-1.8972E-02	1.1882E-01	-9.6029E-02	1.8771E-02	-3.6665E-03
32	-6.1446E-02	5.6833E-01	-1.4347E-01	-3.8408E-01	5.3979E-01	-1.3751E-01	3.6534E-01	-3.5138E-01	1.8990E-01	-3.1662E-02
33	6.1006E-02	1.5975E-02	5.9802E-02	-1.5167E-01	1.5681E-01	3.6423E-02	8.2090E-02	-1.7319E-01	-6.3945E-03	-1.4063E-02
34	2.0744E-01	1.6090E+00	-4.2134E-01	-3.6293E+00	1.8320E+00	-2.4610E-01	1.8404E+00	-1.3302E+00	2.9975E-01	-4.3976E-02
35	1.3360E-01	1.5854E+00	-3.8165E-01	-3.2794E+00	1.1160E+00	-3.5971E-01	1.6387E+00	-6.9986E-01	3.1245E-01	1.3880E-02
36	9.1876E-02	-2.9057E-01	-6.9846E-02	3.5957E-01	-9.0362E-02	1.7140E-01	-1.3735E-01	8.0785E-02	-9.1880E-02	1.1391E-01
37	2.9097E-01	5.5756E-01	-2.8122E-02	-1.8657E+00	5.6031E-01	-1.9727E-01	1.0240E+00	-4.9334E-01	2.7358E-01	-1.0531E-02
38	6.8669E-02	7.2246E-01	2.7573E-01	-1.5242E+00	3.6095E-01	2.9253E-01	7.5610E-01	-5.0665E-01	-2.5287E-01	-5.0926E-02
39	-1.6147E-02	1.6595E+00	-1.9784E-01	-2.7466E+00	1.4253E+00	7.0545E-02	1.1503E+00	-1.2292E+00	6.7200E-03	2.3773E-01
40	5.7611E-01	9.8864E-01	-2.4242E-01	-2.7282E+00	2.6492E+00	-9.2435E-01	1.2248E+00	-2.1794E+00	1.4209E+00	-1.4445E-01
41	2.7914E-01	3.5933E-01	7.6913E-02	-1.1958E+00	8.0727E-01	-3.2947E-01	5.8112E-01	-7.7264E-01	5.0278E-01	-1.4706E-01
42	1.5144E+00	-1.0697E+00	6.3188E-01	-1.9485E+00	9.5042E-01	-1.2063E+00	1.4282E+00	-1.1997E+00	1.6882E+00	-5.0637E-01
43	-6.8577E-01	6.0875E+00	-1.3323E+00	-9.5028E+00	4.7366E+00	-1.9946E-01	4.0743E+00	-3.2513E+00	6.1070E-01	1.4498E-01
44	-8.5303E-01	9.0717E+00	-1.6215E+00	-1.3786E+01	6.7724E+00	-1.2425E-01	5.7107E+00	-4.7042E+00	4.5875E-01	-2.3060E-01
45	-4.3781E-01	5.9420E+00	-2.1714E+00	-8.9593E+00	5.3285E+00	-8.2580E-01	3.4813E+00	-3.1575E+00	1.4231E+00	1.3722E-01
46	1.5196E-01	8.6062E-01	-3.0255E-01	-2.0124E+00	1.2034E+00	-2.2368E-01	1.0007E+00	-9.2174E-01	3.1354E-01	1.5416E-02
47	2.7597E-03	5.8991E-01	-4.5982E-02	-1.0893E+00	1.9856E-01	-5.1324E-02	5.0971E-01	-1.3319E-01	2.8602E-02	3.9735E-04
48	6.9704E-03	1.7277E+00	-1.1889E-01	-3.4007E+00	2.2722E-01	2.9707E-02	1.6421E+00	-1.4828E-01	-3.1035E-02	9.0178E-02
49	1.3124E-01	7.4086E-01	-2.8079E-01	-1.7740E+00	9.7658E-01	-1.2681E-01	9.2571E-01	-5.7537E-01	1.8423E-01	-2.9399E-02
50	3.4316E-02	-2.0131E-01	4.7445E-02	4.7707E-01	-2.5286E-01	9.8779E-02	-2.4471E-01	1.9608E-01	-1.2031E-01	9.8783E-02
51	-1.8811E-03	1.7765E-01	5.7578E-02	-3.6342E-01	6.1616E-02	1.1983E-01	1.9570E-01	-1.2517E-01	-1.1696E-01	1.1140E-02
52	3.1323E-01	-1.1530E-01	4.2274E-01	-5.6411E-01	-6.9737E-01	5.2148E-01	4.1088E-01	3.3461E-01	-6.1260E-01	2.7645E-01
53	-7.7277E-02	1.0703E+00	-2.7462E-01	-1.8548E+00	1.0898E+00	1.4212E-02	9.5630E-01	-6.7196E-01	1.3757E-01	-1.5752E-01
54	2.7796E-01	2.1078E+00	-3.4695E-01	-4.7091E+00	1.6114E+00	1.1241E-01	2.3548E+00	-1.1757E+00	-4.9194E-02	4.9948E-02

E-Notation: 1.0935E-01 = 0.10935

TABLE A-9: ESTIMATES OF COEFFICIENTS OF CUBIC REGRESSIONS, TARGET AREA (CONTINUED)

Band No.	b_{00}	b_{10}	b_{01}	b_{20}	b_{11}	b_{02}	b_{30}	b_{21}	b_{12}	b_{03}
55	1.8578E-02	8.1232E-01	-3.2734E-01	-1.5758E+00	6.9076E-01	-1.4087E-02	7.4807E-01	-4.3861E-01	1.0211E-02	1.6713E-01
56	1.3008E+00	3.6497E+00	-1.9452E-01	-9.6023E+00	1.6276E+00	-2.2456E-01	4.8565E+00	-1.5027E+00	5.0621E-01	1.9376E-01
57	-6.7316E-01	5.0166E+00	-1.4592E+00	-6.6505E+00	4.5155E+00	-8.8389E-01	2.2854E+00	-2.7588E+00	1.4345E+00	-1.6591E-01
58	-3.8679E-01	3.6272E+00	-8.7324E-01	-5.4676E+00	2.5947E+00	-5.3586E-01	2.2617E+00	-1.6307E+00	7.2474E-01	-5.2252E-02
59	-1.3043E-01	6.5975E+00	-1.0613E+00	-1.1278E+01	4.0145E+00	-1.1381E-01	5.1597E+00	-2.8515E+00	6.4994E-01	-1.0812E-01
60	2.9418E-02	-3.6903E-02	1.2847E-01	3.3697E-01	-5.0842E-01	1.9618E-01	-2.2694E-01	4.2944E-01	-1.7987E-01	-7.4527E-02
61	-4.6089E-02	4.3037E-01	-8.8600E-02	-9.5745E-01	3.1250E-01	3.6029E-01	5.6285E-01	-2.2503E-01	-3.8179E-01	2.4752E-02
62	1.1669E-01	1.6517E+00	1.7896E-01	-2.8050E+00	2.6630E-01	5.5351E-01	1.2099E+00	-5.0075E-01	-4.7327E-01	3.0656E-01
63	-8.3566E-02	2.2068E+00	-3.4209E-02	-4.0987E+00	9.7752E-01	1.1519E-01	2.0431E+00	-9.5721E-01	1.2457E-02	3.3062E-02
64	1.6137E-01	1.0145E-01	8.2141E-01	-4.7845E-01	-4.0280E-01	5.3510E-01	2.8502E-01	-1.7559E-01	-6.2563E-01	-3.4071E-01
65	-5.9243E-02	1.8708E+00	-4.1088E-01	-4.2178E+00	2.2879E+00	-9.2371E-02	2.5871E+00	-2.4362E+00	6.1775E-01	1.1025E-01
66	2.8229E-02	-7.4745E-02	1.0478E-01	3.3516E-02	-1.8014E-01	9.6580E-02	4.2755E-03	8.2596E-02	-8.5084E-02	1.7155E-02
67	1.2970E-02	7.9695E-02	-4.6440E-03	-5.8535E-02	3.0737E-02	1.6843E-02	-7.3411E-03	-7.1033E-03	-6.5187E-02	-1.2520E-02
68	4.9192E-02	1.0531E+00	1.9117E-01	-2.1059E+00	6.4032E-01	1.3200E-01	1.1002E+00	-7.2445E-01	-4.9034E-02	-7.2203E-02
69	6.8605E-04	1.0530E+00	-1.3239E-01	-1.4336E+00	3.8635E-01	3.9275E-02	3.8796E-01	1.3940E-02	-1.8142E-01	3.5649E-02
70	3.6032E-02	-2.4961E-02	1.3741E-02	-2.1969E-02	-1.1546E-01	1.2180E-03	2.7576E-02	8.2684E-02	-2.1967E-02	4.8136E-02
71	7.2087E-02	3.7298E-01	-8.7037E-02	-9.4811E-01	7.6306E-01	-1.0747E-01	5.1049E-01	-6.6879E-01	2.3316E-01	-5.9233E-02
72	-1.9362E-02	4.8477E-01	-1.5254E-01	-8.2675E-01	8.4661E-01	-1.2406E-01	3.8771E-01	-7.0343E-01	2.5793E-01	-3.0605E-02
73	-3.5718E-02	6.2986E-01	-1.5097E-01	-1.0315E+00	7.6318E-01	-1.6134E-01	4.2999E-01	-5.3519E-01	2.9562E-01	-5.7625E-02
74	3.9374E-02	8.7567E-01	-1.4952E-01	-1.8485E+00	5.9363E-01	-8.9568E-02	9.4736E-01	-3.7387E-01	5.4895E-02	4.9494E-03
75	7.1066E-01	8.7920E-01	8.9010E-02	-2.2715E+00	3.2320E-01	-6.4612E-01	9.3687E-01	-3.2677E-02	5.9260E-01	-2.7838E-01
76	1.6287E-02	-6.1355E-02	6.6977E-02	9.1368E-02	-9.6174E-02	8.4983E-02	-4.6684E-02	3.4678E-02	-5.8497E-02	1.7421E-02
77	2.7133E-01	2.8191E+00	1.6764E-01	-5.5310E+00	1.7247E+00	-3.4852E-01	2.5545E+00	-1.4720E+00	2.1024E-01	-4.9491E-01
78	-1.9302E-02	2.4470E+00	-5.6461E-01	-4.2772E+00	2.3461E+00	-3.2041E-01	1.8510E+00	-1.6250E+00	5.1710E-01	-3.9623E-02
79	-1.3482E-01	2.6093E+00	-3.2607E-01	-4.0246E+00	2.9453E+00	-2.6390E-01	1.6621E+00	-2.0659E+00	5.5318E-01	-4.5250E-01
80	-1.2113E-01	1.5195E+00	-3.7831E-02	-2.5430E+00	7.2535E-01	-3.0608E-02	1.1445E+00	-4.6950E-01	5.6145E-02	-2.2780E-01
81	5.0944E-02	1.6355E+00	-3.7755E-01	-2.6949E+00	1.1803E+00	-2.4987E-01	1.0557E+00	-7.2071E-01	3.5108E-01	-4.4901E-02
82	1.0091E-02	5.6386E-01	5.6311E-02	-1.0796E+00	4.1909E-02	-4.1569E-02	5.0898E-01	-5.4816E-02	2.6068E-02	-5.9366E-02
83	-2.2032E-01	2.4923E+00	-3.4469E-01	-4.1783E+00	7.7841E-01	-2.0796E-01	1.9124E+00	-4.7381E-01	1.4625E-01	5.2274E-02
84	5.1397E-03	2.7496E+00	-1.1742E-01	-5.6825E+00	8.3684E-01	-1.3017E-01	2.9454E+00	-6.7616E-01	9.5676E-02	-1.4483E-01
85	8.2774E-01	3.3408E+00	-5.4702E-01	-8.4722E+00	3.5393E+00	-5.4154E-01	4.4214E+00	-2.6791E+00	7.3545E-01	-1.6717E-01
86	-2.9555E-02	1.6326E-01	-6.9564E-02	2.5438E-01	-3.6145E-01	2.6655E-01	-1.3307E-01	3.3667E-01	-5.1614E-01	2.1262E-01
87	5.2582E-02	1.1413E-02	1.5599E-01	-3.3315E-02	-2.4732E-01	1.1316E-01	-2.2717E-02	1.3184E-01	-8.2247E-02	-2.7233E-02
88	-6.8312E-02	8.6123E-01	-1.0677E-01	-1.2309E+00	8.2057E-01	-9.3745E-02	4.5987E-01	-6.0043E-01	1.2048E-01	-1.1162E-01
89	-4.6739E-02	4.8228E-01	-1.0433E-01	-8.0969E-01	5.7986E-01	-3.8637E-02	3.6926E-01	-4.4987E-01	7.2957E-02	-1.1235E-02
90	1.8600E-01	7.4477E-01	-3.5900E-01	-1.1331E+00	2.5376E-01	-3.3002E-01	3.0630E-01	-3.8530E-02	2.9324E-01	1.2542E-01
91	-4.4042E-01	1.0171E+01	-2.6850E+00	-1.8465E+01	1.3142E+01	-2.1649E+00	9.0244E+00	-1.0631E+01	4.1875E+00	-1.0746E+00
92	-8.5537E-02	4.3129E+00	-1.6662E+00	-7.0308E+00	3.1327E+00	1.6451E-01	2.9869E+00	-1.2362E+00	-4.2575E-01	2.4453E-01
93	-1.0554E-01	1.9052E+00	-8.6303E-01	-3.8655E+00	3.6052E+00	-4.6029E-01	2.0791E+00	-3.1491E+00	1.3645E+00	-1.0309E-01
94	-4.5233E-02	3.7653E-01	-1.5976E-01	-7.4562E-01	7.4339E-01	-1.4500E-01	4.0938E-01	-6.4156E-01	3.4094E-01	-4.5972E-02
95	1.0866E-01	9.7975E-01	-4.9381E-02	-2.2804E+00	7.0665E-01	-2.0924E-01	1.1625E+00	-5.9431E-01	2.4550E-01	-6.1820E-02
96	6.0395E-01	3.8708E+00	-1.2489E+00	-8.8684E+00	3.5230E+00	-1.0452E+00	4.4057E+00	-2.4071E+00	9.5572E-01	4.0723E-01
97	6.8229E-01	-2.3057E-01	-8.7863E-01	-1.5337E+00	1.6169E+00	-7.0270E-01	9.5986E-01	-9.7365E-01	5.9232E-01	3.9902E-01
98	-2.0951E-02	9.8611E-01	-5.8755E-02	-1.7009E+00	6.4442E-01	-1.2279E-01	7.5423E-01	-4.7376E-01	1.0504E-01	-6.1125E-02
99	-1.0297E-01	7.6929E+00	-1.8204E+00	-1.4628E+01	7.7522E+00	-1.3856E+00	7.2020E+00	-6.0668E+00	2.3090E+00	-3.8412E-01
100	-2.1156E-02	6.9640E-01	-3.7252E-01	-1.2151E+00	1.6382E+00	-2.7166E-01	5.7559E-01	-1.3529E+00	6.6187E-01	-1.4337E-01
101	-5.7292E-03	4.3743E-01	-1.9981E-01	-9.5509E-01	6.8335E-01	-9.1159E-02	5.3164E-01	-5.5358E-01	2.4661E-01	-1.4252E-02
102	9.0521E-02	1.0176E-01	-1.4560E-01	-5.8585E-01	6.7050E-01	-1.7318E-01	3.9754E-01	-6.0097E-01	3.3705E-01	-2.7459E-02
103	-1.8857E-01	2.5954E+00	-4.2463E-01	-4.6423E+00	2.0425E+00	-1.0279E-01	2.2021E+00	-1.4326E+00	1.4665E-01	-1.7079E-01
104	2.1814E-01	-7.1319E-01	2.4005E-01	6.9422E-01	-4.7628E-01	3.0105E-01	-1.9969E-01	2.4374E-01	-3.2031E-01	-4.8668E-02
105	3.5547E-01	1.7108E+00	3.8437E-02	-4.0393E+00	1.2291E-01	2.9364E-01	2.0600E+00	-1.9062E-01	-3.8746E-01	1.8284E-01
106	1.8434E-01	2.9607E-01	-7.0676E-02	-9.7298E-01	2.3916E-01	7.8107E-02	5.6350E-01	-2.8707E-01	-2.7088E-02	3.0768E-01
107	1.0393E+00	-2.6217E+00	5.0372E-01	2.5004E+00	-9.7992E-01	-2.4038E-01	-8.6571E-01	5.1083E-01	2.7705E-01	-2.8971E-02

TABLE A-10: ESTIMATES OF COEFFICIENTS OF CUBIC REGRESSIONS, CONTROL AREA

Band No.	b_{00}	b_{10}	b_{01}	b_{20}	b_{11}	b_{02}	b_{30}	b_{21}	b_{12}	b_{03}
1	1.9616E-01	3.1878E-01	6.2421E-01	4.3013E-01	-4.4251E+00	-3.7693E+00	-4.0652E+00	1.3370E+01	-1.7623E+01	-1.3681E+01
2	2.2571E-01	-6.6941E-01	-8.9503E-01	-4.7364E-01	-1.6806E+00	7.4014E-01	1.5279E+00	2.5846E+01	1.4435E+01	8.0733E+00
3	1.0569E-01	-2.6272E-01	-3.7357E-01	-1.2151E+00	-1.8081E+00	6.1409E-02	1.9124E+00	1.7065E+01	-4.6497E+00	7.4689E+00
4	3.6571E-02	6.6613E-01	-3.9983E-01	1.0278E+00	-1.2677E+00	3.3251E-01	-7.1261E+00	1.1093E+01	-2.0541E+01	4.8665E+00
5	1.1672E-01	3.1935E-01	1.5449E-01	3.1747E+00	-4.1150E+00	8.6460E-01	-7.5206E+00	-6.2129E+00	-1.7039E+01	-5.9209E+00
6	1.1931E-01	8.9076E-02	5.4215E-01	2.6730E+00	-4.2440E+00	-7.3471E-01	-1.0498E+00	-2.5530E+01	1.8053E+01	-1.0075E+01
7	7.4187E-02	2.0956E-01	-4.3994E-01	3.7973E+00	-6.3545E-01	-1.7759E-01	6.9328E+00	-1.8841E+01	-1.4798E+01	3.7628E+00
8	1.1227E-02	6.8673E-02	4.2598E-02	3.8696E-02	-2.0679E-01	-6.9767E-02	-3.7966E-02	-2.0226E+00	-7.6078E-01	-9.1794E-01
9	2.2667E-02	1.3766E-01	6.8547E-03	-2.4559E-02	-3.7826E-01	-2.3345E-01	-5.2050E-01	-1.5411E+00	-1.6117E+00	-2.4812E-01
10	1.3249E-02	8.5144E-02	-1.7168E-01	2.9051E-01	3.5868E-01	2.5102E-01	-2.3489E+00	7.1608E+00	-6.8845E+00	1.5311E+00
11	1.5413E-01	-1.2007E-02	-3.3962E-01	5.8285E-01	-2.4678E+00	5.6601E-01	-2.9963E+00	1.4245E+01	4.5925E+00	2.9267E+00
12	3.5197E-01	-1.3142E+00	7.1217E-01	-2.4095E+00	1.3730E+00	-9.9546E-01	1.0581E+01	-1.4012E+01	1.5327E+01	-6.5267E+00
13	1.0926E-01	-7.5472E-01	5.8744E-01	-1.1567E+00	5.8128E-01	-1.1897E-01	7.8820E+00	-1.5144E+01	8.0106E+00	-4.6170E+00
14	8.9648E-02	2.6511E-01	-8.3420E-02	1.0481E+00	-1.0315E+00	1.4788E-01	-2.6331E+00	-6.8894E-01	9.4555E+00	-2.2187E+00
15	8.7429E-02	5.6429E-01	-8.3113E-01	3.0720E+00	-6.2114E+00	2.7548E+00	-5.3350E+00	5.6176E+00	6.9792E+00	1.4069E+01
16	5.2620E-02	1.1198E+00	-5.7568E-01	1.7118E+00	7.5119E-01	2.4413E+00	-7.0893E+00	-3.3944E+00	-4.4441E+01	1.8650E+01
17	9.4116E-01	-1.6900E+00	-7.5212E-01	-3.1151E+00	7.1341E+00	-2.9275E+00	5.6453E+00	3.2649E+01	1.9223E+01	1.0518E+01
18	7.1323E-01	1.7487E+00	-5.4057E-01	1.5076E+00	-2.6928E+00	2.2123E+00	-7.0401E+00	-2.2781E+01	-2.7179E+01	1.4184E+01
19	4.7863E-01	5.0312E-01	5.3272E-01	-6.0757E+00	2.5128E+01	-1.3247E+00	8.1181E+00	-1.0185E+01	-1.6793E+02	3.1025E+01
20	4.5724E-02	-4.2853E-01	1.3779E-01	-2.3271E+00	4.1058E+00	-5.4394E-01	5.9233E+00	4.8815E+00	-1.8849E+01	1.6568E+00
21	1.3282E-01	2.7617E-01	7.5244E-02	1.1233E+00	-7.8344E+00	1.1441E+00	2.8501E+00	-1.9669E+01	3.4886E+01	-1.4802E+01
22	1.0085E-01	2.7591E-02	-3.5996E-01	1.0607E+00	-3.5240E+00	4.3047E-02	-3.9823E+00	1.2488E+01	1.0079E+01	3.6146E+00
23	2.7384E-01	9.7076E-02	3.4955E-01	-9.0054E-01	1.8024E-01	-9.6903E-01	-7.5736E-01	8.4407E-01	3.0503E+00	-5.5826E+00
24	2.0904E-01	7.7237E-02	-4.2276E-01	-2.1978E-01	-8.8713E-01	-3.4402E-01	-7.0310E-01	2.1460E+00	4.1499E+00	5.7551E+00
25	1.0849E-01	-2.8036E-01	3.3298E-01	-2.1475E-01	-6.9859E-01	-8.1076E-01	3.2909E+00	-5.0949E+00	5.8997E+00	-6.5307E+00
26	1.3428E-01	3.1314E-01	-2.4106E-01	-5.7790E-01	-1.4034E+00	-1.4155E+00	-2.3873E+00	8.4611E+00	5.4443E+00	1.6561E+00
27	7.0466E-02	-8.6566E-02	1.4567E-01	8.8756E-02	-4.4811E-01	5.0674E-01	3.3766E+00	-5.7146E-01	-7.3357E-01	-3.0691E+00
28	1.2686E-01	2.0546E-01	1.0328E-01	1.3861E+00	-3.1433E-01	-1.4811E-01	7.7033E-01	-4.3671E+00	-6.2207E+00	-3.7180E+00
29	1.5069E-01	-1.5727E-01	-1.5442E-01	-1.6090E-01	-3.2305E+00	-6.1066E-01	-3.8715E-01	8.7899E+00	1.3275E+00	5.2860E+00
30	2.5446E-01	2.4196E-01	-1.1296E+00	4.1064E-01	-2.1623E+00	-1.0969E-01	-4.5324E+00	1.6542E+01	8.3967E+00	6.7981E+00
31	1.1473E-01	-5.4759E-01	7.1228E-01	-1.1131E-01	4.9794E-02	-5.3421E-01	3.5713E+00	-6.8602E+00	4.8196E+00	-6.2745E+00
32	7.7205E-02	-4.4587E-02	6.4096E-02	9.8916E-02	-9.0973E-02	-1.1220E-01	6.7333E-01	-7.4913E+00	2.1049E+00	-1.0016E+00
33	6.2649E-02	-7.5034E-01	3.2403E-01	2.1539E+00	-1.8562E-01	5.6194E-01	-6.6512E-01	3.2953E-01	2.5084E+00	-3.6233E+00
34	2.8824E-01	-4.9819E-01	-1.2391E-01	3.4437E-01	3.1533E-01	-5.6482E-01	1.6267E+00	-1.9818E+00	2.9199E+00	-1.0804E-01
35	1.5627E-01	-1.4257E-01	3.4652E-01	-5.3756E-01	3.5733E-01	4.2289E-01	3.1740E+00	-1.7708E+00	-2.1250E+00	-3.8953E+00
36	1.2487E-01	-2.5842E-01	2.5008E-01	-2.0949E-01	2.8104E-01	-5.8593E-01	1.2909E+00	-6.3956E-01	4.0700E-01	-4.1900E+00
37	2.7843E-01	-9.4508E-02	2.1169E-01	1.8164E+00	-1.0711E+00	-1.1270E+00	-3.9833E+00	7.1562E+00	8.0802E-02	-7.5263E+00
38	1.8823E-01	-1.4666E+00	-3.2792E-01	6.1418E+00	1.7497E+00	-1.4968E+00	-6.4792E+00	-6.1504E+00	2.2220E+00	2.4472E+00
39	4.7492E-01	-2.6166E+00	9.7769E-01	-2.9860E-01	3.7198E+00	-1.8982E+00	2.0027E+01	-3.3941E+01	5.4805E+00	-1.9610E+01
40	4.3547E-01	-2.1241E+00	-9.2211E-01	-4.2302E+00	1.4529E+00	-1.1572E+00	2.3428E+01	7.5743E+00	2.3105E+01	-7.9679E-01
41	1.3936E-01	-9.4888E-01	-8.1857E-01	-1.1870E+00	5.5424E-01	1.5136E+00	5.2995E+00	1.6985E+01	1.3063E+01	1.4726E+00
42	3.1715E-01	3.7252E-01	-6.9529E-01	-1.2345E+00	-8.5535E-01	1.3790E+00	6.2094E+00	7.8965E+00	-2.6038E+01	-3.3038E-01
43	6.7542E-01	-3.7122E+00	-4.5544E-01	-5.5406E+00	-1.2245E-01	-1.9224E+00	3.0869E+01	3.7785E+01	9.7480E+01	-4.4550E-01
44	3.6777E-01	3.6311E-02	5.0998E-01	1.0062E+00	4.7031E+00	3.4385E+00	8.1792E+00	-3.0352E+01	-3.7902E+01	-1.4340E+01
45	7.4156E-01	-1.2132E+00	-6.8017E-01	-3.0311E+00	-5.8831E-01	-1.2994E+00	1.1444E+01	1.7754E+01	3.7171E+01	-5.6997E-01
46	1.0632E-01	-5.9182E-01	-2.6406E-01	1.0930E+00	-3.0135E-01	-4.5292E-01	-4.8056E-01	4.0958E-01	2.6825E+00	2.7202E+00
47	2.9064E-02	-7.0585E-02	-1.3333E-01	-2.3078E-01	-1.3532E-01	-8.9942E-02	1.6284E+00	2.0662E+00	1.2093E+00	6.0771E-01
48	1.7451E-01	-1.4678E-01	-1.8001E-01	-1.2102E-01	-1.2005E+00	-1.1730E+00	-9.4064E-01	7.8639E+00	2.6413E+00	2.7567E+00
49	7.0821E-01	3.7647E-01	-2.1464E-01	-1.8767E-01	4.1272E-02	-1.1674E+00	9.4692E-01	6.9222E+00	-7.7257E+00	-6.3840E-02
50	1.2765E-01	4.6912E-02	2.5455E-01	4.0452E-01	-7.5367E-01	7.9153E-01	-1.9792E+00	3.1583E-01	-9.5181E-01	1.0166E+00
51	7.2063E-02	-2.6113E-01	1.0878E-01	1.6080E-01	9.6731E-01	-8.7743E-01	3.9624E-01	2.5934E-01	-5.3484E+00	-2.2248E-01
52	2.3274E-01	-1.1745E+00	2.3075E-01	6.8303E-01	1.8014E+01	-3.9568E+00	-4.5821E+00	3.2144E+01	-1.1169E+02	1.4922E+01
53	1.6240E-01	-1.3159E-01	2.5349E-01	3.9542E-01	-3.0111E-01	1.0073E+00	-2.1124E+00	9.0959E+00	-9.4108E+00	-7.4116E+00
54	4.7193E-01	-9.4144E-01	2.0296E-01	-3.6049E-02	3.3097E-01	-5.5920E-01	6.2440E+00	-4.2635E+00	-6.9736E-01	-9.3099E+00

TABLE A-10: ESTIMATES OF COEFFICIENTS OF CUBIC REGRESSIONS, CONTROL AREA (CONTINUED)

Band No.	b_{00}	b_{10}	b_{01}	b_{20}	b_{11}	b_{02}	b_{30}	b_{21}	b_{12}	b_{03}
55	1.1224E-01	-3.1055E-01	1.7461E-01	7.1598E-02	1.1822E+00	-7.1028E-01	1.4867E+00	1.8238E+00	-7.8827E+00	-1.9842E+00
56	6.0670E-01	-1.3935E+00	-7.8244E-01	1.7321E-01	-5.3287E-02	-5.5617E+00	1.2791E+01	-1.4691E+01	-1.3735E+01	1.5817E+01
57	4.4715E-01	7.9441E-01	-1.5545E+00	-3.1250E-01	-9.3529E+00	-9.3257E-01	4.9827E+00	1.0347E+00	3.7083E+01	1.1230E+01
58	1.4962E-01	4.4893E-01	-5.8952E-01	-4.4934E-01	-3.4613E+00	-6.6015E-01	-5.7262E-01	1.6719E+01	-1.7658E+00	7.0558E+00
59	6.5714E-01	-3.7068E-01	-8.1510E-01	-7.6132E-01	7.8712E+00	-2.4141E-01	7.8078E+00	-7.2672E+00	-2.4156E+01	1.1026E+01
60	5.8610E-02	1.8668E-01	-1.2276E-01	-2.9605E-01	5.3762E-01	-5.2017E-01	9.1543E-01	1.3855E+00	-7.0748E+00	1.4617E+00
61	2.2467E-01	-7.6820E-01	5.9672E-01	-1.6736E-01	1.0290E+00	-1.7435E+00	7.2258E+00	-1.4462E+01	-3.9251E+00	-5.5177E+00
62	4.2791E-01	-1.9031E+00	7.1020E-01	3.7304E+00	-2.6547E+00	-1.0624E+00	5.2071E+00	-7.5566E+00	9.8449E+00	-7.6817E+00
63	5.9860E-01	-2.9434E-01	2.1391E-02	-5.6015E-01	1.8965E+00	-2.2015E+00	-1.4724E+00	3.8075E+00	-2.8659E+00	8.8205E-02
64	5.8038E-01	2.8696E-01	7.7289E-01	-1.2095E-01	-6.4197E+00	-4.1736E+00	-5.4977E+00	2.1410E+01	-6.4288E+00	-7.5416E+00
65	5.4078E-01	-1.7726E+00	9.9670E-01	-2.7615E+00	-4.3171E-01	-3.3289E+00	8.7260E+00	-6.4217E+00	1.2796E+01	-1.4984E+01
66	8.4440E-02	-1.3511E-01	-2.4323E-01	1.9551E+00	-1.5312E+00	-9.9871E-01	-5.7502E+00	8.2667E+00	-1.4202E+00	3.7489E+00
67	2.6954E-02	-9.6072E-02	-1.1666E-02	7.2484E-01	-7.8714E-01	-7.2938E-02	-1.3411E+00	1.1030E+00	-1.2164E+00	1.1271E+00
68	2.3156E-01	-9.0797E-01	-7.4226E-02	3.6652E-01	-4.5494E+00	-2.1741E+00	2.4782E-01	1.7720E+01	1.3244E+01	7.2860E-01
69	2.0367E-01	2.7250E-01	2.0843E-01	2.4584E+00	-1.2187E+00	-1.0615E+00	-7.8510E+00	-3.8299E+00	-5.0246E+00	-5.4226E-01
70	6.2567E-02	-1.2607E-04	-1.4154E-01	-3.2215E-01	1.4599E-01	-4.7941E-01	7.9653E-01	-1.5409E-01	-6.7420E-01	2.8948E+00
71	2.8408E-01	9.1150E-01	5.7067E-01	-2.5114E-02	1.4010E+00	-1.3303E+00	-8.2124E-03	-9.7999E+00	-1.7762E+01	-8.6464E+00
72	1.5776E-01	3.5550E-01	-6.0656E-02	5.1691E-01	6.0501E-02	-4.9428E-01	-1.0335E+00	1.1296E-02	-2.9640E+00	-1.2089E+00
73	1.5674E-01	-1.0059E-01	-4.7608E-02	-3.8361E-01	-1.1147E+00	-5.2308E-01	5.7529E-01	3.7565E+00	8.6554E+00	-3.0029E+00
74	1.4693E-01	5.9654E-02	1.6590E-01	7.2342E-01	-4.8950E-01	-1.0391E+00	2.3950E+00	-1.4910E+00	3.6583E+00	-5.3719E+00
75	4.5880E-02	-2.0434E-02	-4.9309E-01	-2.1614E-03	-3.3766E-01	1.1896E+00	-6.9172E-01	2.2140E+00	1.6498E+00	2.6375E-01
76	7.0827E-02	-6.4156E-02	-2.7825E-01	1.1313E+00	-1.6048E+00	-1.6859E-02	-3.2388E+00	6.9584E+00	5.4691E+00	4.4036E+00
77	3.6055E-01	-8.4491E-01	-1.1251E+00	-2.2412E-01	2.7729E-01	-1.0538E+00	2.1257E+00	3.0151E+00	-7.6314E-01	8.9976E+00
78	4.3267E-01	-5.2197E-01	2.3773E+00	1.3265E+00	-5.2759E+00	-3.9320E-01	1.5774E+00	1.7029E+01	-2.0016E+00	-3.5401E+01
79	3.9047E-01	-4.5484E-01	3.0795E-02	5.3548E-01	5.1399E-01	4.7159E-01	3.2670E-01	-1.2042E+00	-1.1001E+01	-4.2671E+00
80	3.7585E-01	3.4494E-01	2.9762E-01	-2.9220E+00	-1.0398E+00	-3.7097E+00	3.3848E+00	-3.3593E-01	4.4317E+00	-7.3640E+00
81	6.6144E-02	3.4595E-01	2.8597E-01	3.2218E-01	3.9573E-01	1.0010E+00	2.1974E-01	-1.6787E-01	-1.2179E+01	-8.5595E+00
82	2.7147E-01	7.0534E-01	2.5168E-01	-4.6245E-01	-2.4722E+00	-3.7737E+00	-1.7123E+00	5.5823E+00	2.8520E+00	-6.0670E+00
83	2.3329E-01	-7.7391E-01	1.0532E+00	-2.7674E+00	-1.4848E+00	-3.5829E+00	3.4330E+00	5.5772E+00	2.1824E+01	-2.2498E+01
84	1.1784E-01	-4.3168E-01	-4.0511E-01	2.9786E-01	1.0056E+00	9.9819E-01	-2.8181E-01	-1.5080E+00	6.3887E+00	6.5579E+00
85	7.5178E-01	-2.0324E-01	-1.7105E+00	3.1514E+00	-3.2997E+00	1.5269E+00	-2.4261E+00	7.5718E+00	-5.8504E+00	4.5936E+01
86	1.7232E-01	9.3994E-01	-6.0229E-01	7.6156E-01	-5.6736E-01	1.0554E+00	-4.5187E+00	7.7908E+00	4.8031E+00	2.0941E+01
87	3.9156E-02	6.2842E-01	-5.4671E-01	3.7696E+00	-3.8845E+00	7.1197E-01	-1.3453E+01	1.9910E+01	1.3576E+01	5.0645E+00
88	1.6230E-01	1.6106E-01	-2.2885E-01	-1.3441E+00	1.1985E+00	-1.4935E+00	-5.3704E-01	7.8806E-01	6.7807E+00	-4.4605E+00
89	7.6617E-02	-5.8236E-01	2.8390E-01	7.0427E-01	-7.5335E-01	2.0997E+00	1.9472E+00	-2.5561E+00	-8.0892E+00	4.6350E+00
90	4.9332E-02	-3.6148E-01	-4.2984E-02	1.0471E+00	5.0221E-01	-4.3600E-01	-8.4350E-01	-1.2271E+00	8.1983E-01	9.6250E-02
91	7.1032E-01	-6.7358E-01	-1.8179E-01	-2.1500E+00	1.6155E+00	8.2402E+00	9.8690E+00	-4.9041E+00	-2.6328E+01	-2.7373E+01
92	1.0485E-01	3.4679E-01	-8.0497E-01	3.9057E-01	-6.6026E-02	7.8241E-01	1.8711E+00	-4.7728E+00	-4.1313E+00	2.1848E+01
93	2.3871E-01	2.4420E-01	-4.9246E-02	2.0261E+00	-3.1225E-01	-1.0723E+00	-2.4039E+00	7.6205E+00	-1.2922E+01	-2.3759E+01
94	5.6596E-02	1.0812E-01	-1.3759E-01	5.7451E-02	4.8924E-02	3.4363E-01	9.7835E-01	-7.1771E-02	-5.6594E+00	-1.9784E+00
95	1.1387E-01	-6.2752E-01	-3.0763E-02	1.3978E+00	-8.1977E-01	-1.0000E+00	-6.9729E-01	2.5330E+00	2.9826E+00	1.7874E+00
96	2.9370E-01	-1.2997E+00	2.3520E-01	2.6011E+00	-3.7634E+00	-6.5349E-01	-2.4623E+00	1.1295E+01	5.5060E-01	-2.5480E+00
97	3.3644E-01	-8.1321E-01	5.7790E-01	1.6577E+00	-2.4904E+00	-3.6362E+00	-1.1438E+00	4.5714E+00	4.9671E+00	-2.7875E+00
98	6.2214E-02	-1.2205E-01	1.6115E-01	-2.3512E-01	1.6725E-01	1.8083E-01	1.5124E+00	-1.2160E+00	-4.5187E-01	-2.3410E+00
99	6.7413E-01	-3.7079E-02	-1.7333E-01	2.2500E+00	3.1455E+00	7.7496E-01	-5.7840E+00	-2.2555E+00	1.3346E+00	3.7072E+00
100	5.7828E-02	2.3943E-01	-1.2257E-01	1.1740E+00	-4.0319E-01	7.7470E-01	-3.2827E+00	9.3621E-01	2.7539E+00	2.6932E+00
101	1.3356E-01	2.4004E-01	2.6072E-01	-2.3139E-01	9.8723E-02	-1.9709E-01	-8.4565E-01	1.7463E-01	-1.3258E-01	-4.2067E+00
102	7.4266E-02	2.0349E-01	1.9869E-02	-2.1647E-01	-1.7539E-01	-2.1621E-03	-7.3955E-01	1.2814E+00	2.5629E-01	-1.2716E+00
103	2.1781E-01	-5.2792E-01	-1.9332E-01	-1.5323E+00	8.2891E-01	-1.3709E+00	4.6920E+00	-2.4112E+00	-2.1358E+00	-1.6751E-01
104	5.5616E-02	-5.1486E-01	-9.2550E-02	7.6026E-01	1.6000E+00	1.0771E-01	7.8510E-01	-5.0755E+00	-5.0662E-01	2.5905E+00
105	4.4209E-01	1.5631E-01	6.2065E-01	3.4984E+00	9.1533E-01	-1.7420E-01	-1.0459E+00	-1.8354E+01	-3.5608E+01	-7.8037E+00
106	2.9047E-01	9.1871E-01	2.6440E-01	7.5235E-01	1.5274E+00	6.4360E-01	-3.4670E+00	-1.7198E+01	-2.4618E+01	-2.4602E+00
107	2.7196E-01	-1.0535E-01	2.5113E-01	7.9239E-01	3.4013E+00	2.5507E+00	2.1755E+00	-1.1037E+01	-9.3207E+00	3.3368E+00

TABLE A-11: VOLUMES OF PRECIPITATION AND THEIR VARIANCES FOR VARIOUS GEOGRAPHICAL AREAS IN THE TARGET AREA AND FOR THE CONTROL AREA

	(i) All Target		(ii) Santa Barbara		(iii) Ventura & Los Angeles		(iv) (ii) + (iii)		(v) All Control	
Band No.	Vol.[1]	Var.	Vol.	Var.	Vol.	Var.	Vol.	Var.	Vol.	Var.
1	.0901	.010254	.0155	.000059	.0960	.000933	.1115	.000868	.0007	.012454
2	.4275	.015303	.0671	.000088	.1864	.001392	.2535	.001294	.1138	.010459
3	.2848	.032350	.0528	.000184	.2319	.002933	.2847	.002743	.0117	.000520
4	.0624	.003265	.0211	.000019	.0486	.000295	.0697	.000276	-.0163	.000250
5	.1507	.001552	.0402	.000039	.1214	.000304	.1616	.000266	.0808	.002282
6	.0895	.000706	.0239	.000018	.0454	.000139	.0694	.000121	.1592	.002196
7	.1218	.000571	.0240	.000008	.0644	.000115	.0885	.000107	.2391	.037691
8	-.0007	.000017	.0032	.000000	.0021	.000004	.0052	.000004	.0074	.000032
9	.0498	.000059	.0039	.000001	.0385	.000013	.0424	.000012	.0053	.000057
10	.0377	.000068	.0076	.000001	.0133	.000015	.0208	.000014	-.0115	.000080
11	.1636	.000939	.0576	.000013	.0856	.000208	.1432	.000195	.0800	.000620
12	.3281	.001178	.0650	.000016	.1292	.000262	.1942	.000245	.1386	.000976
13	.1169	.000302	.0175	.000004	.0444	.000067	.0618	.000063	.0674	.000740
14	.0372	.000369	.0291	.000005	.0100	.000083	.0391	.000078	.0841	.001879
15	.4801	.017325	.0942	.000239	.3190	.003411	.4132	.003230	.1785	.006067
16	.0383	.002665	.0481	.000036	.0497	.000554	.0979	.000529	.0341	.004627
17	.7191	.005149	.1555	.000069	.3214	.000975	.4769	.000891	.3217	.015802
18	.0612	.001297	.0331	.000017	.0222	.000272	.0553	.000262	.1608	.002917
19	.9742	.030650	.1951	.000674	.6396	.006020	.8346	.005535	-.1387	.026831
20	.0523	.000485	.0318	.000011	.0427	.000096	.0745	.000088	-.0537	.002875
21	.0764	.002742	.0211	.000060	.0858	.000538	.1068	.000493	.2149	.008298
22	.0321	.001317	.0222	.000022	.0148	.000400	.0371	.000533	.0632	.000356
23	.1567	.000561	.0560	.000006	.0850	.000138	.1410	.000125	.0928	.000263
24	.1599	.000611	.0598	.000009	.0947	.000199	.1545	.000186	.0910	.000158

Footnotes: [1] The unit of measurement for volumes is inches per degree of latitude by degree of longitude. Very approximately, one degree of latitude by one degree of longitude is 4,000 square miles.

TABLE A-11: VOLUMES OF PRECIPITATION AND THEIR VARIANCES FOR VARIOUS GEOGRAPHICAL AREAS IN THE TARGET AREA AND FOR THE CONTROL AREA

	(i) All Target		(ii) Santa Barbara		(iii) Ventura & Los Angeles		(iv) (ii) + (iii)		(v) All Control	
Band No.	Vol.[1]	Var.	Vol.	Var.	Vol.	Var.	Vol.	Var.	Vol.	Var.
1	.0901	.010254	.0155	.000059	.0960	.000973	.1115	.000868	.0003	.012454
2	.4275	.015303	.0671	.000088	.1864	.001392	.2535	.001294	.1138	.010459
3	.2848	.032350	.0528	.000184	.2319	.002933	.2847	.002743	.0117	.000520
4	.0624	.003265	.0211	.000019	.0486	.000295	.0697	.000276	-.0163	.000250
5	.1507	.001552	.0402	.000039	.1214	.000304	.1616	.000266	.0808	.002282
6	.0895	.000706	.0239	.000018	.0454	.000139	.0694	.000121	.1592	.002196
7	.1218	.000571	.0240	.000008	.0644	.000115	.0885	.000107	.2391	.037691
8	-.0007	.000017	.0032	.000000	.0021	.000004	.0052	.000004	.0074	.000032
9	.0498	.000059	.0039	.000001	.0385	.000013	.0424	.000012	.0053	.000057
10	.0377	.000060	.0076	.000001	.0133	.000015	.0208	.000014	-.0115	.000080
11	.1636	.000939	.0576	.000013	.0856	.000208	.1432	.000195	.0800	.000620
12	.3281	.001178	.0650	.000016	.1292	.000262	.1942	.000245	.1386	.000976
13	.1169	.000302	.0175	.000004	.0444	.000067	.0618	.000063	.0674	.000740
14	.0372	.000369	.0291	.000005	.0100	.000083	.0391	.000078	.0841	.001879
15	.4801	.017325	.0942	.000239	.3190	.003411	.4132	.003230	.1785	.006067
16	.0383	.002665	.0481	.000036	.0497	.000554	.0979	.000529	.0341	.004627
17	.7191	.005149	.1555	.000069	.3214	.000975	.4769	.000891	.3217	.015802
18	.0612	.001297	.0331	.000017	.0222	.000272	.0553	.000262	.1608	.002917
19	.9742	.030650	.1951	.000674	.6396	.006020	.8346	.005535	-.1387	.026831
20	.0523	.000485	.0318	.000011	.0427	.000096	.0745	.000088	-.0537	.002875
21	.0764	.002742	.0211	.000060	.0858	.000538	.1068	.000493	.2149	.008298
22	.0321	.001317	.0222	.000022	.0148	.000400	.0371	.000533	.0632	.000356
23	.1567	.000561	.0560	.000006	.0850	.000138	.1410	.000125	.0928	.000263
24	.1599	.000611	.0596	.000009	.0947	.000199	.1545	.000186	.0910	.000158

Footnotes: [1]The unit of measurement for volumes is inches per degree of latitude by degree of longitude. Very approximately, one degree of latitude by one degree of longitude is 4,000 square miles.

TABLE A-11: VOLUMES OF PRECIPITATION AND THEIR VARIANCES FOR VARIOUS GEOGRAPHICAL AREAS IN THE TARGET AREA AND FOR THE CONTROL AREA (CONTINUED)

	(i) All Target		(ii) Santa Barbara		(iii) Ventura & Los Angeles		(iv) (ii) + (iii)		(v) All Control	
Band No.	Vol.[1]	Var.	Vol.	Var.	Vol.	Var.	Vol.	Var.	Vol.	Var.
25	.1504	.000390	.0272	.000004	.0660	.000095	.0932	.000088	.0636	.000034
26	.0375	.000988	.0310	.000011	.0448	.000247	.0758	.000231	.0266	.000181
27	.0219	.000052	.0049	.000001	.0093	.000019	.0142	.000017	.0777	.000062
28	.1974	.001596	.0524	.000028	.1038	.000576	.1562	.000536	.1206	.000193
29	.0211	.000116	.0141	.000001	.0008	.000030	.0149	.000031	.0504	.000189
30	.3333	.000995	.0689	.000023	.1447	.000308	.2137	.000278	.1160	.000304
31	.0185	.000081	.0062	.000003	.0142	.000027	.0204	.000025	.0614	.000107
32	.0128	.000146	.0141	.000006	.0171	.000048	.0312	.000045	.0265	.000019
33	.1162	.000211	.0306	.000009	.0449	.000062	.0754	.000058	.0694	.000458
34	.5063	.001350	.0555	.000057	.3510	.000395	.4365	.000371	.1397	.000161
35	.4042	.001536	.0464	.000065	.3074	.000451	.3539	.000423	.0884	.000104
36	.1413	.000326	.0145	.000014	.0858	.000096	.1013	.000090	.0454	.000174
37	.4023	.001217	.0613	.000039	.2550	.000330	.3163	.000313	.1356	.000256
38	.3614	.004814	.1029	.000148	.1357	.001268	.2386	.001148	.1351	.000706
39	.4566	.049184	.1443	.000855	.2142	.016886	.3585	.023147	.2734	.004232
40	.9092	.014635	.2092	.000438	.5268	.004010	.7361	.003606	.2318	.000836
41	.4044	.002044	.0825	.000065	.2330	.000588	.3155	.000528	.0830	.000553
42	1.2064	.011288	.1776	.000361	.7572	.003277	.9348	.002936	.1811	.000634
43	.5599	.075276	.2211	.001320	.3394	.025952	.5605	.035609	.4242	.002955
44	1.2108	.042965	.3570	.001317	.7986	.011980	1.1556	.011081	.2902	.002811
45	.8274	.016741	.1787	.000530	.7617	.004783	.9404	.004412	.1187	.000736
46	.3302	.000559	.0537	.000017	.2333	.000165	.2871	.000151	.0492	.000315
47	.1053	.000241	.0170	.000007	.0753	.000071	.0933	.000064	.0215	.000025
48	.2983	.001106	.0406	.000033	.2239	.000324	.2645	.000296	.0519	.000123

TABLE A-11: VOLUMES OF PRECIPITATION AND THEIR VARIANCES FOR VARIOUS GEOGRAPHICAL AREAS IN THE TARGET AREA AND FOR THE CONTROL AREA (CONTINUED)

	(i) All Target		(ii) Santa Barbara		(iii) Ventura & Los Angeles		(iv) (ii) + (iii)		(v) All Control	
Band No.	Vol.[1]	Var.	Vol.	Var.	Vol.	Var.	Vol.	Var.	Vol.	Var.
49	.2989	.000775	.0518	.000023	.2020	.000228	.2538	.000208	.1022	.000147
50	.1172	.000122	.0242	.000004	.0442	.000038	.0683	.000034	.0677	.000084
51	.0802	.000193	.0210	.000005	.0255	.000058	.0466	.000052	.0099	.000610
52	.5007	.002235	.0644	.000052	.2422	.000675	.3266	.000607	-.2055	.056377
53	.4194	.008795	.0600	.000150	.2154	.003060	.2954	.004204	.0599	.000757
54	.8605	.002915	.1466	.000079	.5417	.000819	.6883	.000757	.2331	.004914
55	.1734	.000896	.0292	.000024	.1357	.000253	.1649	.000229	.0348	.002334
56	2.4871	.041779	.3469	.001131	1.6410	.011851	1.9878	.010683	.4193	.055811
57	.2984	.013334	.1544	.000404	.3084	.003770	.4628	.003454	.3412	.011560
58	.2704	.005756	.0786	.000163	.2471	.001611	.3257	.001479	.0913	.001005
59	1.8601	.044463	.3290	.001257	1.1623	.012417	1.4913	.011402	.3250	.015548
60	.2501	.001161	.0272	.000032	.1515	.000325	.1787	.000298	.0415	.000241
61	.1075	.000598	.0198	.000015	.0468	.000182	.0666	.000175	.1082	.005969
62	.9354	.006191	.2061	.000183	.4625	.001901	.6685	.001775	.2943	.003684
63	.5058	.002713	.1125	.000080	.2362	.000828	.3487	.000775	.1608	.001130
64	.4158	.036059	.1015	.000142	.1427	.003007	.2441	.002805	.1684	.001661
65	.5355	.027602	.0747	.000058	.1735	.002367	.2482	.002246	.1565	.000760
66	.0492	.000033	.0127	.000001	.0100	.000010	.0227	.000009	.0201	.000122
67	.0519	.000154	.0066	.000005	.0414	.000048	.0480	.000045	.0155	.000033
68	.4637	.020819	.1109	.000126	.1822	.002202	.2932	.002287	.1211	.000392
69	.2046	.010331	.0701	.000060	.1728	.001109	.2428	.001145	.0893	.000524
70	.0467	.000063	.0047	.000002	.0260	.000018	.0307	.000017	.0211	.000077
71	.1855	.000708	.0331	.000014	.0967	.000167	.1358	.000172	.1424	.002631
72	.1382	.000268	.0377	.000005	.0625	.000063	.1003	.000065	.0938	.000325

TABLE A-11: VOLUMES OF PRECIPITATION AND THEIR VARIANCES FOR VARIOUS GEOGRAPHICAL AREAS IN THE TARGET AREA AND FOR THE CONTROL AREA (CONTINUED)

	(i) All Target		(ii) Santa Barbara		(iii) Ventura & Los Angeles		(iv) (ii) + (iii)		(v) All Control	
Band No.	Vol.[1]	Var.	Vol.	Var.	Vol.	Var.	Vol.	Var.	Vol.	Var.
73	.0972	.000965	.0375	.000015	.0537	.000314	.0913	.000429	.0707	.000673
74	.1716	.002703	.0312	.000043	.1147	.000880	.1459	.001202	.1218	.001241
75	1.1151	.003901	.1455	.000095	.7921	.001084	.9376	.001004	.0306	.000083
76	.0495	.000096	.0155	.000003	.0123	.000028	.0278	.000026	.0454	.000162
77	.8225	.011085	.1541	.000255	.5425	.003316	.6965	.003155	.1216	.000212
78	.4716	.005671	.1162	.000130	.3371	.001694	.4532	.001612	.2164	.000428
79	.5903	.006644	.1908	.000161	.3027	.001946	.4935	.001857	.2302	.000356
80	.1612	.024185	.0458	.000396	.1061	.008396	.1520	.011475	.0724	.000165
81	.4395	.002764	.0780	.000066	.3464	.000838	.4244	.000796	.0599	.000038
82	.1012	.000848	.0153	.000020	.0709	.000243	.0863	.000230	.0455	.000788
83	.1384	.004495	.0167	.000096	.1467	.001361	.1634	.001298	-.0094	.000967
84	.4477	.003387	.0461	.000081	.3097	.001027	.3559	.001004	.0635	.000279
85	1.6038	.014156	.2653	.000406	1.0285	.004493	1.2938	.004461	.4690	.001294
86	.3078	.000419	.0301	.000010	.1612	.000133	.1913	.000122	.1479	.000139
87	.1331	.000382	.0286	.000010	.0680	.000118	.0966	.000108	.0742	.000223
88	.1271	.001663	.0444	.000045	.0800	.000514	.1244	.000470	.0223	.000200
89	.0398	.000408	.0225	.000011	.0140	.000123	.0365	.000114	.0671	.000199
90	.4041	.001279	.0230	.000037	.3806	.000367	.4036	.000338	.0211	.000094
91	2.1425	.175746	.4365	.001133	1.2237	.022612	1.6602	.024362	.2085	.001778
92	.8709	.069179	.1273	.000469	.8047	.008890	.9319	.009599	.1172	.000318
93	.5471	.016717	.1005	.000080	.2663	.002436	.3668	.002615	.1347	.001006
94	.0607	.000279	.0158	.000001	.0162	.000041	.0320	.000044	.0420	.000087
95	.2075	.004886	.0402	.000085	.1375	.001702	.1777	.002335	.0536	.000102
96	1.0208	.006484	.1342	.000229	.8319	.001939	.9661	.001781	.1261	.000233

TABLE A-11: VOLUMES OF PRECIPITATION AND THEIR VARIANCES FOR VARIOUS GEOGRAPHICAL AREAS IN THE TARGET AREA AND FOR THE CONTROL AREA (CONTINUED)

	(i) All Target		(ii) Santa Barbara		(iii) Ventura & Los Angeles		(iv) (ii) + (iii)		(v) All Control	
Band No.	Vol.[1]	Var.	Vol.	Var.	Vol.	Var.	Vol.	Var.	Vol.	Var.
97	.7466	.007477	.0532	.000262	.6333	.002216	.6865	.002040	.1239	.000365
98	.1471	.000725	.0342	.000025	.1050	.000217	.1392	.000200	.0338	.000028
99	1.5585	.062860	.2735	.000537	.9986	.007432	1.2721	.007919	.3393	.000474
100	.2791	.003955	.0517	.000038	.1584	.000466	.2101	.000504	.0636	.000012
101	.1212	.002204	.0168	.000028	.0689	.000566	.0856	.000777	.0585	.000022
102	.1393	.000564	.0157	.000006	.0774	.000067	.0931	.000072	.0325	.000012
103	.2173	.002259	.0679	.000071	.1535	.000668	.2214	.000595	.0502	.000366
104	.1796	.000531	.0209	.000018	.0914	.000157	.1122	.000139	.0339	.000191
105	.8743	.007075	.1263	.000197	.5546	.002126	.6809	.001972	.2509	.000861
106	.4066	.006314	.0805	.000106	.1948	.002142	.2754	.002943	.1471	.000153
107	.6533	.001732	.0533	.000045	.4219	.000439	.4752	.000401	.2034	.000583

TABLE A-12: MEANS OF PRECIPITATIONS AND THEIR VARIANCES FOR VARIOUS GEOGRAPHICAL AREAS IN THE TARGET AREA AND FOR THE CONTROL AREA

	(i) All Target		(ii) Santa Barbara		(iii) Ventura & Los Angeles		(iv) (ii) + (iii)		(v) All Control	
Band No.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.
1	.0637	.000065	.1138	.000650	.0495	.000042	.0645	.000066	.1013	.000727
2	.1028	.000104	.1938	.000941	.0793	.000054	.1041	.000105	.2540	.000517
3	.1665	.000131	.1706	.000662	.1678	.000167	.1684	.000131	.0900	.000207
4	.0376	.000015	.0494	.000066	.0350	.000020	.0381	.000016	.0563	.000075
5	.1527	.000098	.1428	.000342	.1503	.000130	.1565	.000096	.1450	.000523
6	.0392	.000033	.0861	.000262	.0264	.000024	.0395	.000034	.0975	.000241
7	.0352	.000029	.0964	.000105	.0161	.000025	.0356	.000031	.1125	.000300
8	.0022	.000001	.0062	.000008	.0008	.000000	.0022	.000001	.0058	.000004
9	.0075	.000004	.0048	.000005	.0083	.000007	.0074	.000004	.0105	.000010
10	.0146	.000004	.0310	.000017	.0093	.000003	.0149	.000004	.0342	.000026
11	.1134	.000156	.2241	.000449	.0763	.000140	.1157	.000161	.1800	.000153
12	.1482	.000196	.3019	.000701	.0983	.000103	.1511	.000201	.2795	.000598
13	.0358	.000022	.0886	.000104	.0173	.000008	.0362	.000023	.0784	.000239
14	.0228	.000031	.0990	.000153	.0061	.000003	.0305	.000033	.1000	.000210
15	.3682	.000663	.4115	.003398	.3648	.000806	.3765	.000661	.1594	.000432
16	.0857	.000106	.1340	.000591	.0723	.000119	.0878	.000111	.1229	.000199
17	.3433	.000668	.6095	.003089	.2574	.000312	.3507	.000672	.8920	.001801
18	.0606	.000030	.1165	.000586	.0432	.000057	.0622	.000083	.2383	.000714
19	.5642	.001301	.7395	.008096	.5223	.001310	.5746	.001312	.5481	.002068
20	.0336	.000028	.0668	.000220	.0237	.000022	.0341	.000029	.0375	.000133
21	.0868	.000088	.0826	.000244	.0910	.000133	.0890	.000090	.0847	.000606
22	.0367	.000020	.0600	.000139	.0305	.000019	.0376	.000021	.1059	.000163
23	.0959	.000060	.1652	.000181	.0665	.000027	.0975	.000062	.2365	.000183
24	.1094	.000066	.1752	.000182	.0833	.000046	.1121	.000066	.1883	.000124

TABLE A-12: MEANS OF PRECIPITATIONS AND THEIR VARIANCES FOR VARIOUS GEOGRAPHICAL AREAS IN THE TARGET AREA AND FOR THE CONTROL AREA (CONTINUED)

	(i) All Target		(ii) Santa Barbara		(iii) Ventura & Los Angeles		(iv) (ii) + (iii)		(v) All Control	
Band No.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.
25	.0547	.000025	.0860	.000050	.0383	.000026	.0527	.000024	.0870	.000064
26	.0577	.000044	.0786	.000288	.0507	.000033	.0594	.000045	.0904	.000174
27	.0091	.000003	.0157	.000013	.0068	.000004	.0097	.000003	.1039	.000246
28	.1267	.000139	.2070	.000791	.1009	.000052	.1357	.000142	.1570	.000287
29	.0094	.000008	.0343	.000080	.0002	.000000	.0097	.000009	.1330	.000258
30	.1625	.000115	.2595	.000506	.1226	.000057	.1622	.000121	.2582	.000647
31	.0127	.000006	.0176	.000026	.0121	.000008	.0136	.000006	.1100	.000202
32	.0224	.000013	.0257	.000062	.0235	.000019	.0241	.000014	.0326	.000012
33	.0572	.000039	.1200	.000185	.0343	.000028	.0558	.000044	.1217	.000567
34	.3091	.000264	.3480	.000814	.3237	.000347	.3296	.000245	.2743	.000207
35	.2360	.000195	.1705	.000138	.2697	.000318	.2455	.000212	.1709	.000121
36	.0640	.000045	.0585	.000122	.0689	.000079	.0663	.000052	.1083	.000095
37	.2126	.000178	.2500	.000491	.2134	.000261	.2262	.000179	.2864	.000284
38	.1735	.000618	.4338	.004846	.1038	.000324	.1844	.000699	.2355	.003063
39	.2462	.001036	.4914	.007317	.1906	.000935	.2649	.001158	.4236	.003950
40	.4562	.001733	.6733	.006247	.4143	.002636	.4806	.002005	.3338	.001991
41	.1968	.000303	.2936	.000678	.1790	.000471	.2094	.000330	.1433	.000513
42	.5890	.002471	.7164	.005429	.5997	.004144	.6306	.002630	.3100	.000791
43	.4399	.001615	.7448	.008502	.3597	.001495	.4639	.001743	.6280	.002067
44	.3224	.004625	1.2152	.022533	.7400	.005187	.8701	.004899	.4463	.001431
45	.5955	.001989	.4087	.006157	.7020	.002787	.6381	.002039	.1779	.000563
46	.1911	.000107	.2096	.000329	.2025	.000135	.2044	.000095	.1035	.000399
47	.0637	.000024	.0730	.000092	.0660	.000035	.0679	.000025	.0317	.000073
48	.1911	.000176	.2143	.000526	.2039	.000248	.2067	.000169	.1430	.000108

TABLE A-12: MEANS OF PRECIPITATIONS AND THEIR VARIANCES FOR VARIOUS GEOGRAPHICAL AREAS IN THE TARGET AREA AND FOR THE CONTROL AREA (CONTINUED)

	(i) All Target		(ii) Santa Barbara		(iii) Ventura & Los Angeles		(iv) (ii) + (iii)		(v) All Control	
Band No.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.
49	.1796	.000092	.1800	.000246	.1903	.000145	.1875	.000094	.2017	.000543
50	.0372	.000022	.0745	.000068	.0183	.000016	.0348	.000023	.1495	.000206
51	.0390	.000030	.0909	.000165	.0221	.000016	.0419	.000034	.0635	.000082
52	.2257	.000444	.4087	.002442	.1800	.000279	.2449	.000466	.3635	.004636
53	.1972	.000141	.2557	.000488	.1653	.000181	.1910	.000151	.1952	.000270
54	.4697	.000506	.5914	.002256	.4858	.000520	.5144	.000463	.4600	.000773
55	.1197	.000098	.1022	.000442	.1381	.000122	.1280	.000100	.1155	.000211
56	1.2920	.004899	1.4357	.019994	1.3363	.006098	1.3641	.004683	.7714	.005467
57	.2910	.001256	.3186	.006650	.3066	.001720	.3099	.001383	.3414	.002823
58	.2128	.000492	.1887	.001208	.2371	.000847	.2233	.000537	.1873	.000541
59	.9720	.003603	1.1317	.006981	.9481	.006596	1.0002	.003996	.6955	.002202
60	.0960	.000104	.0852	.000071	.0993	.000224	.0953	.000119	.0927	.000075
61	.0781	.000097	.1274	.000256	.0749	.000156	.0838	.000108	.1700	.000689
62	.4371	.001193	.8100	.007079	.3353	.000450	.4669	.001310	.4745	.003353
63	.2502	.000441	.4722	.002379	.1817	.000228	.2622	.000501	.4318	.000844
64	.1807	.000942	.4795	.004665	.0757	.000438	.1830	.000961	.4691	.002051
65	.1702	.000325	.3235	.002252	.1102	.000067	.1715	.000332	.3996	.001193
66	.0161	.000010	.0562	.000072	.0051	.000003	.0176	.000011	.0872	.000304
67	.0272	.000012	.0181	.000015	.0337	.000021	.0296	.000013	.0356	.000051
68	.2014	.000523	.4150	.003012	.1283	.000296	.2052	.000566	.2820	.000658
69	.1823	.000155	.2205	.000582	.1785	.000207	.1896	.000155	.2096	.000362
70	.0167	.000005	.0171	.000022	.0195	.000006	.0188	.000005	.0452	.000038
71	.0932	.000053	.1443	.000330	.0811	.000041	.0985	.000055	.2392	.000530
72	.0622	.000030	.1222	.000098	.0433	.000021	.0649	.000033	.1538	.000103

TABLE A-12: MEANS OF PRECIPITATIONS AND THEIR VARIANCES FOR VARIOUS GEOGRAPHICAL AREAS IN THE TARGET AREA AND FOR THE CONTROL AREA (CONTINUED)

	(i) All Target		(ii) Santa Barbara		(iii) Ventura & Los Angeles		(iv) (ii) + (iii)		(v) All Control	
Band No.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.	Mean	Var.
73	.0629	.000027	.1096	.000099	.0498	.000024	.0660	.000028	.1400	.000132
74	.1170	.000045	.1222	.000133	.1216	.000072	.1218	.000048	.1467	.000466
75	.5473	.000557	.4963	.000835	.6025	.000833	.5744	.000526	.0744	.000280
76	.0194	.000013	.0626	.000077	.0056	.000004	.0208	.000015	.0865	.000157
77	.4737	.001309	.5654	.003403	.4817	.002018	.5048	.001322	.2854	.001352
78	.3176	.000481	.3496	.002003	.3327	.000632	.3374	.000479	.4670	.002620
79	.3446	.000819	.5992	.002460	.2637	.000915	.3542	.000911	.4246	.000547
80	.1193	.000308	.1048	.001602	.1098	.000412	.1251	.000341	.1914	.000654
81	.2678	.000233	.2732	.000916	.2875	.000291	.2836	.000220	.1039	.000185
82	.0588	.000061	.0663	.000121	.0614	.000110	.0627	.000067	.1304	.000460
83	.1265	.000316	.0724	.000161	.1508	.000632	.1285	.000350	.1115	.000501
84	.2709	.000331	.2413	.000464	.3073	.000554	.2862	.000333	.1412	.000246
85	.9040	.002028	1.0458	.007530	.9361	.002441	.9667	.001860	.8248	.001840
86	.1006	.000068	.0978	.000166	.0870	.000066	.0895	.000048	.2329	.000934
87	.0579	.000042	.1214	.000190	.0431	.000037	.0632	.000047	.1254	.000549
88	.0601	.000140	.1429	.000305	.0689	.000176	.0878	.000160	.1165	.000195
89	.0316	.000036	.0604	.000200	.0238	.000045	.0344	.000041	.0925	.000395
90	.2110	.000246	.0591	.000149	.2853	.000230	.2287	.000248	.0473	.000186
91	1.0084	.003900	1.3955	.026068	.9498	.003656	1.0625	.004079	.3821	.002319
92	.6492	.002209	.4595	.001452	.7690	.003709	.6889	.002341	.1550	.000625
93	.2063	.000312	.3271	.001670	.1797	.000261	.2213	.000328	.2636	.001480
94	.0170	.000007	.0408	.000029	.0078	.000003	.0173	.000007	.0693	.000122
95	.1328	.000137	.1721	.000614	.1367	.000182	.1467	.000144	.1133	.000379
96	.6634	.001917	.5704	.004903	.7951	.002405	.7336	.001739	.3024	.001675

TABLE A-12: MEANS OF PRECIPITATIONS AND THEIR VARIANCES FOR VARIOUS GEOGRAPHICAL AREAS IN THE TARGET AREA AND FOR THE CONTROL AREA (CONTINUED)

	(i) All Target		(ii) Santa Barbara		(iii) Ventura & Los Angeles		(iv) (ii) + (iii)		(v) All Control	
Band No.	Mean	Var.	Mean	Var	Mean	Var.	Mean	Var.	Mean	Var.
97	.4362	.001502	.2435	.001072	.5718	.002375	.4819	.001583	.2806	.001240
98	.0940	.000083	.1239	.000289	.0954	.000129	.1032	.000091	.0652	.000049
99	.8258	.001957	.9139	.009425	.8597	.002320	.8744	.001904	.6828	.000954
100	.1082	.000089	.1300	.000443	.1085	.000125	.1140	.000098	.1039	.000091
101	.0542	.000023	.0581	.000045	.0563	.000040	.0568	.000025	.1252	.000070
102	.0562	.000019	.0564	.000027	.0613	.000034	.0600	.000020	.0694	.000037
103	.1836	.000271	.2400	.000069	.1878	.000443	.2012	.000293	.1455	.000550
104	.0783	.000082	.1252	.000339	.0734	.000119	.0862	.000093	.0714	.000335
105	.4610	.000779	.5986	.003392	.4642	.000060	.4990	.000733	.5019	.001066
106	.1624	.000195	.2904	.001636	.1552	.000130	.1896	.000214	.3232	.000350
107	.2741	.000465	.2458	.001189	.3035	.000730	.2896	.000493	.3438	.000638

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20. ABSTRACT

This paper reports on one of a series of investigations on summarization of precipitation data in weather modification experiments. A response surface approach is used with raingage location coordinates as independent variables. The method is applied to data made available by North American Weather Consultants from Phase I of their Santa Barbara Convective Test Seeding Program. After investigations, two-dimensional general cubic functions were used to describe precipitation response. These surfaces were integrated to produce total precipitation measurements over designated target areas of interest and the variances of such estimates were obtained. Advantages of the approach lie in the flexibility of the choice of target area and the permissible variation in the impact area of a particular convective band.

last page